

Figure 5CZ



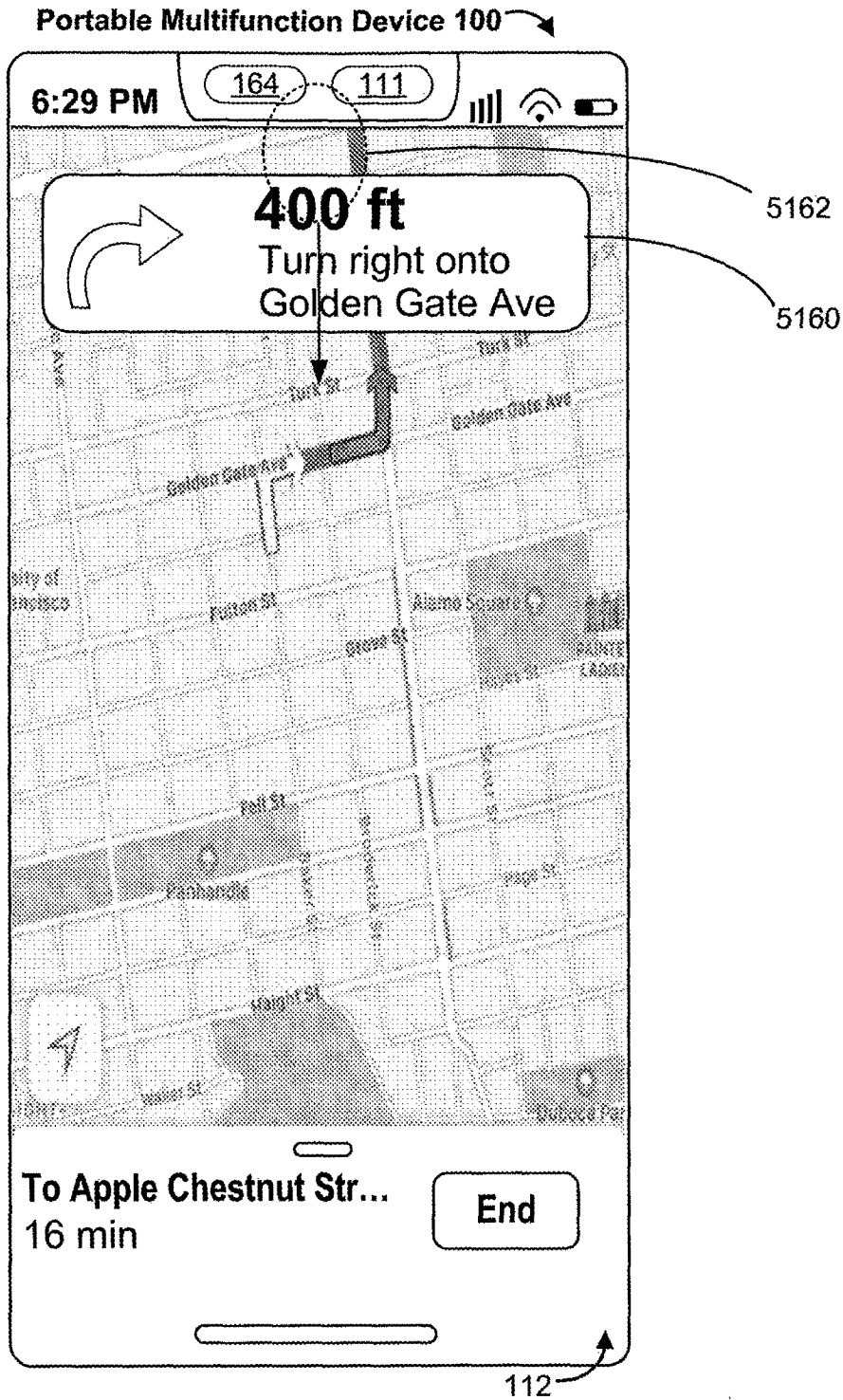
Figure 5DA

## U.S. Patent

**Aug. 31, 2021**

Sheet 116 of 253

US 11,106,352 B2



### Figure 5DB

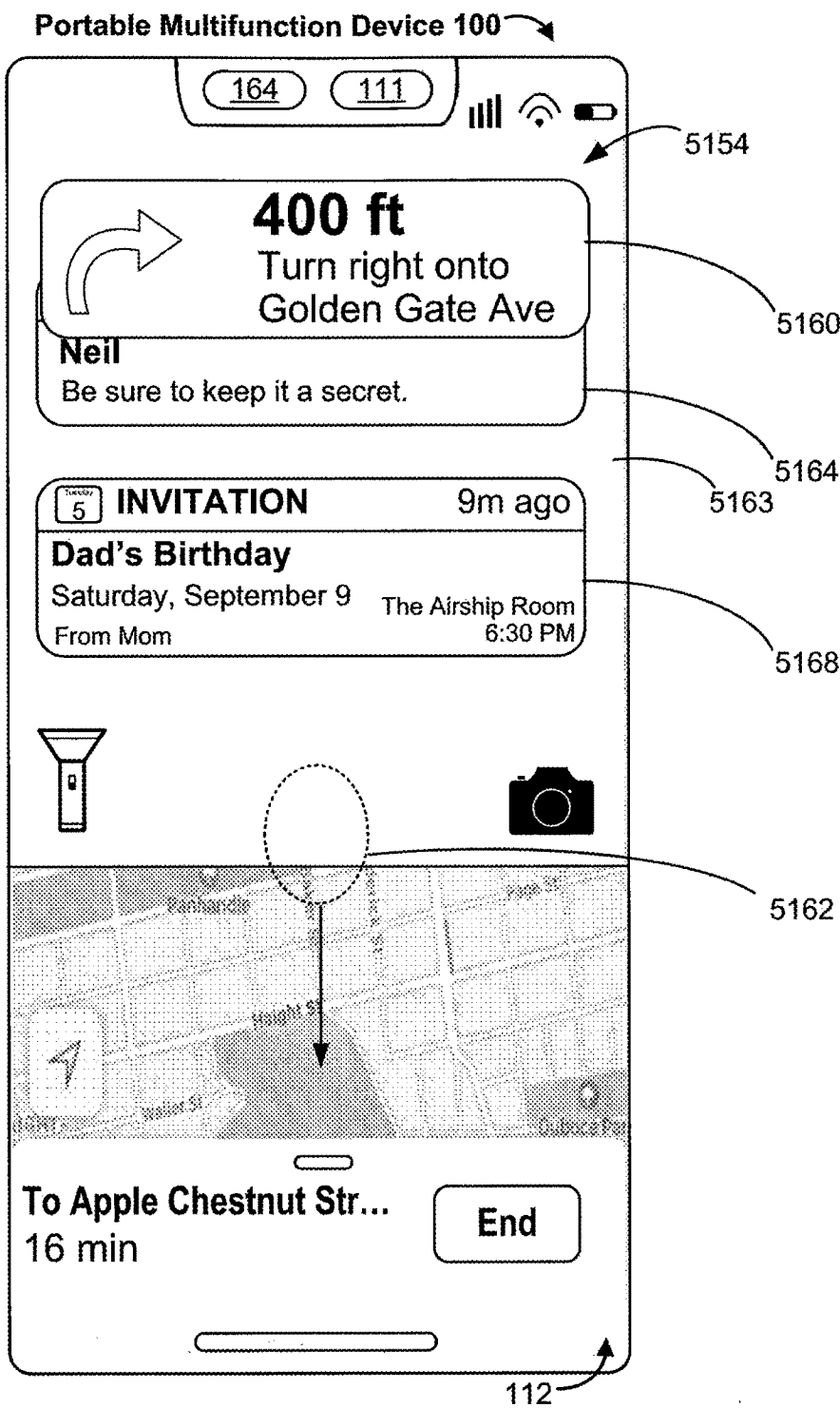


Figure 5DC



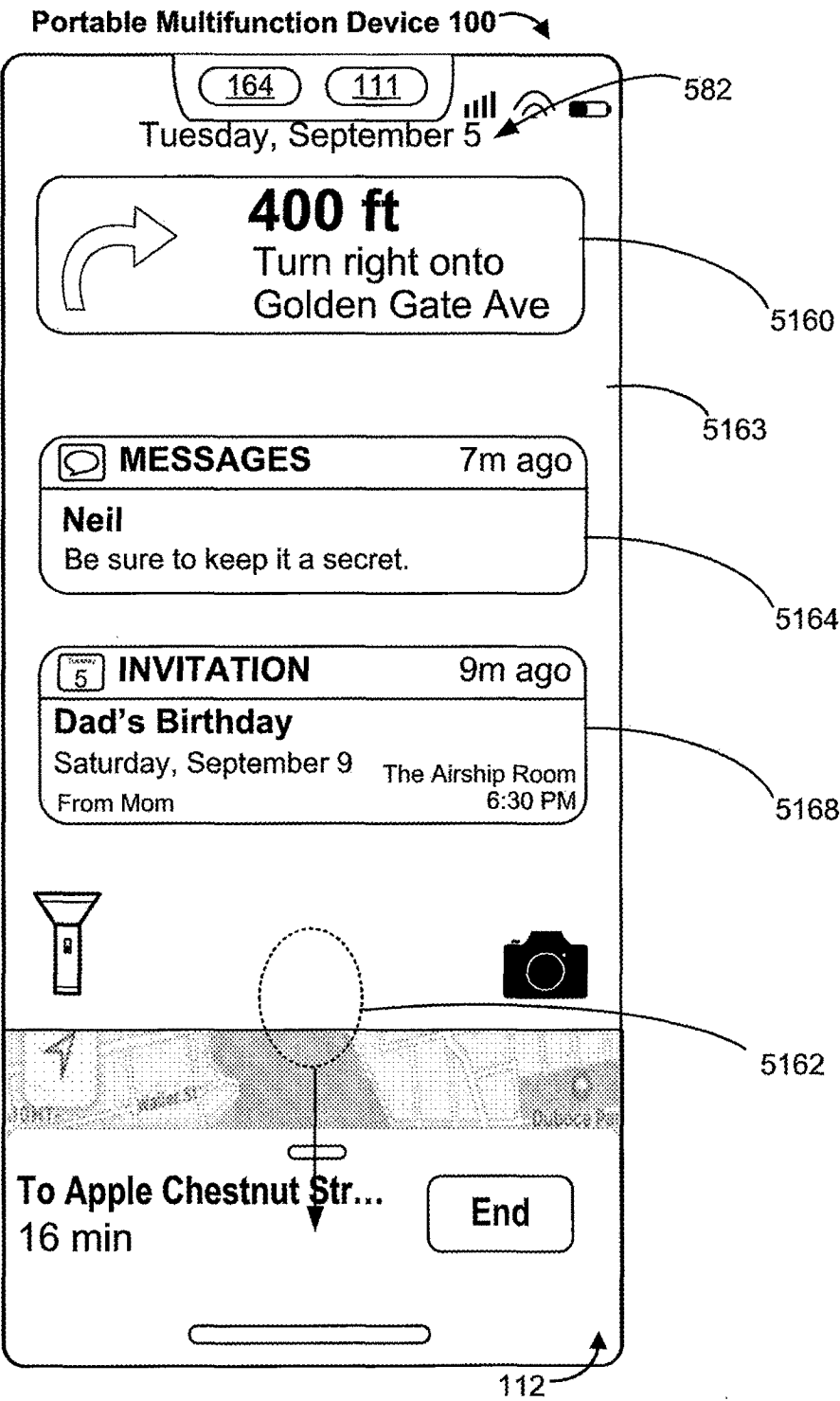


Figure 5DD



Figure 5DE



Figure 5DF

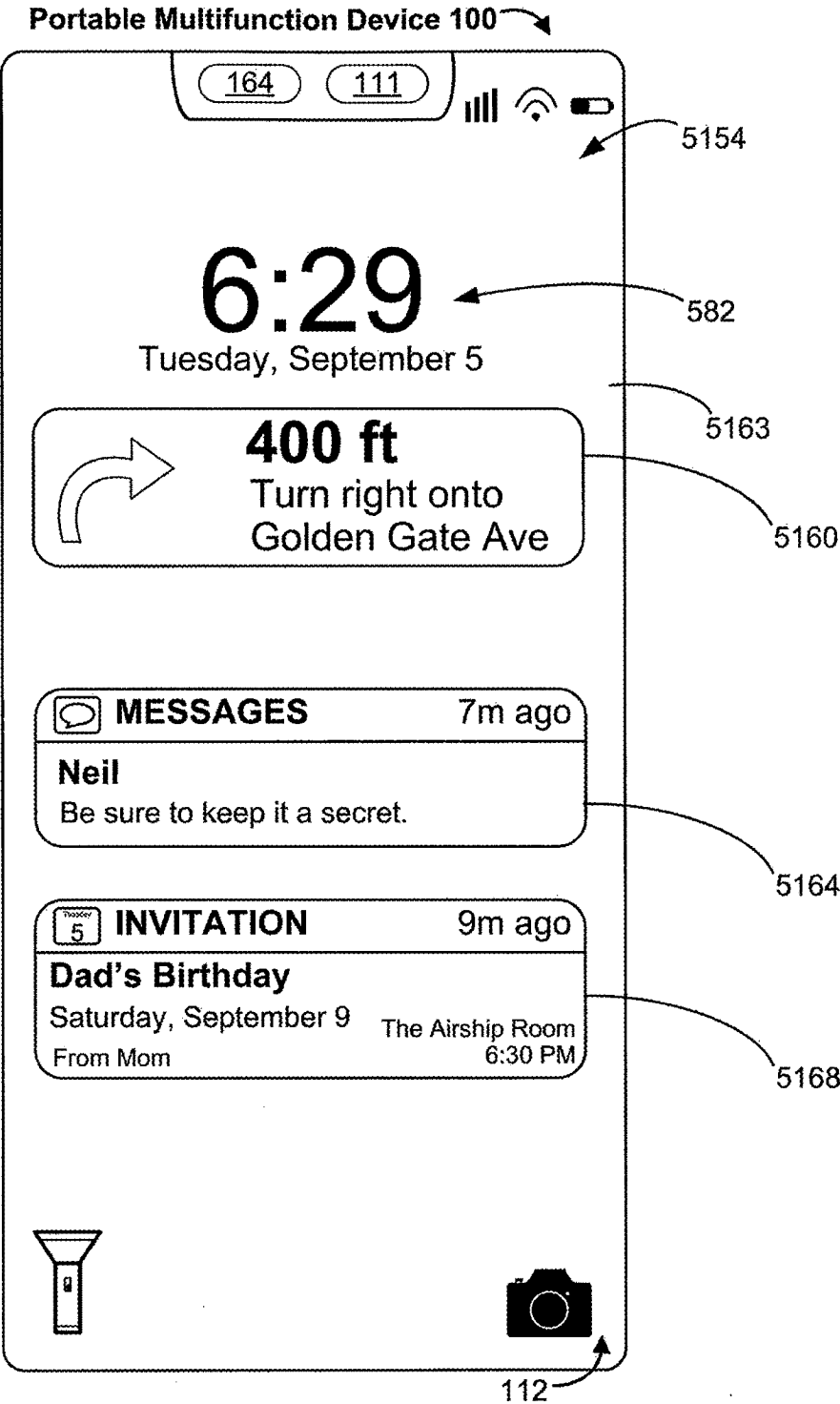


Figure 5DG

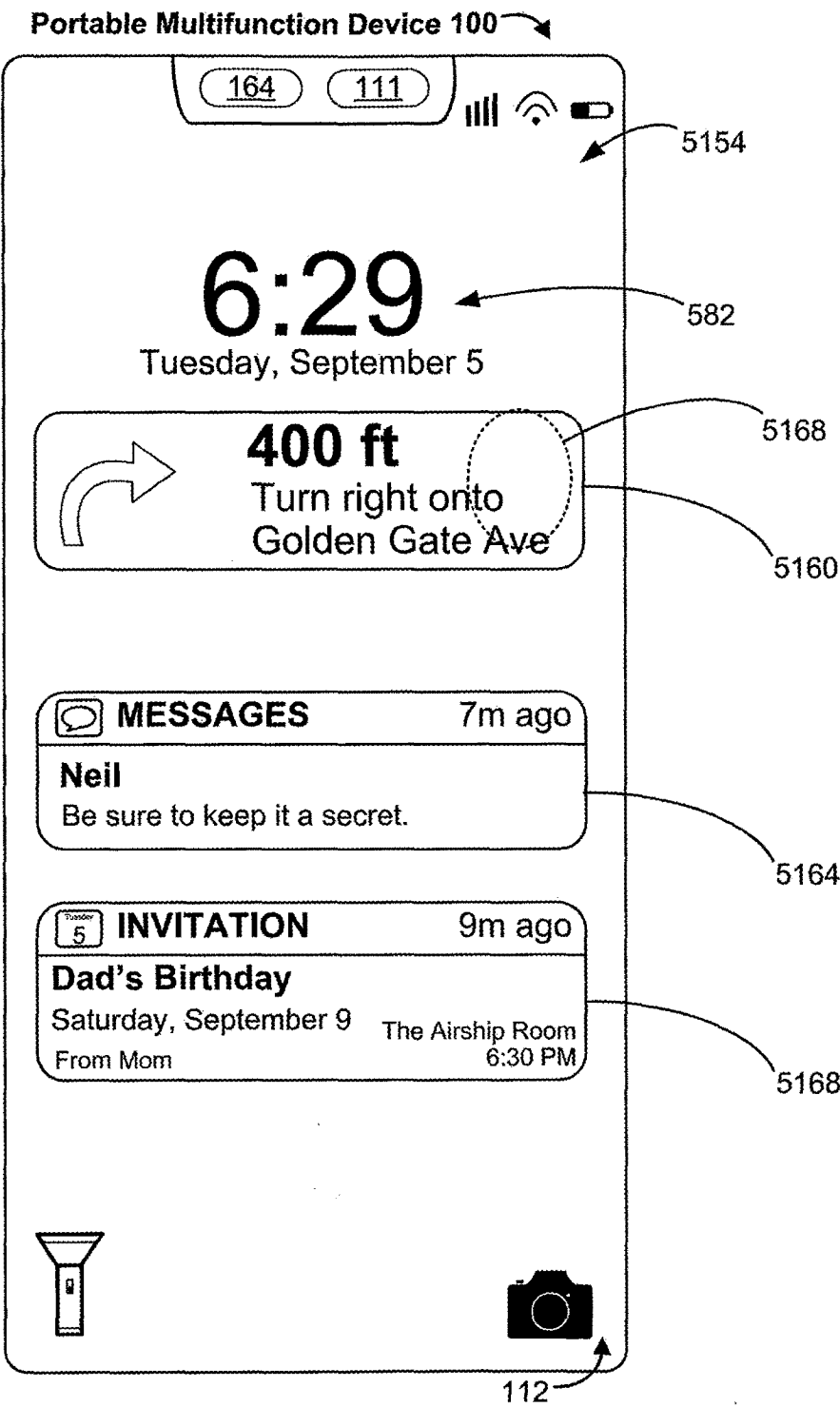


Figure 5DH





Figure 5DI



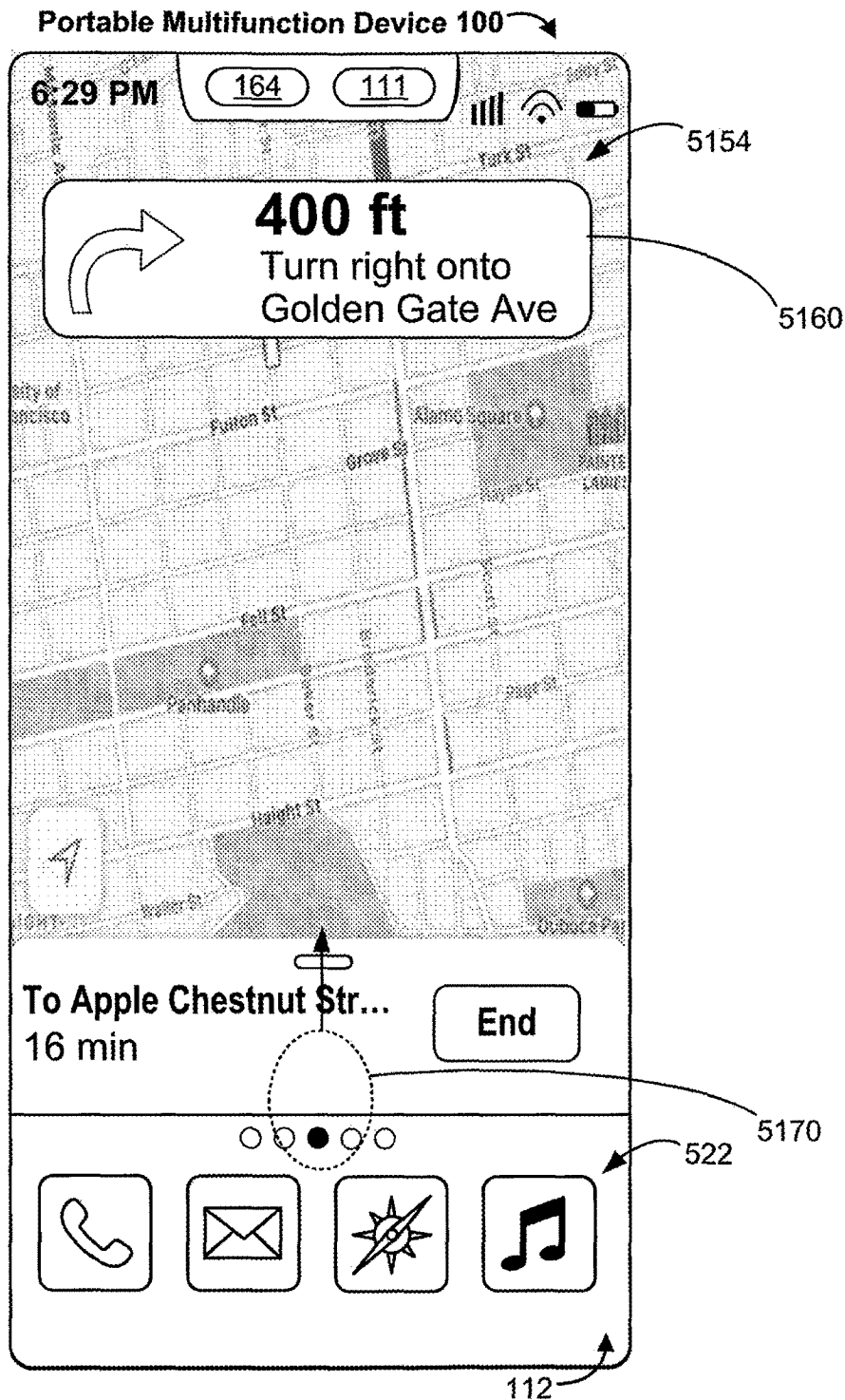
Figure 5DJ

## U.S. Patent

**Aug. 31, 2021**

Sheet 125 of 253

US 11,106,352 B2



### Figure 5DK

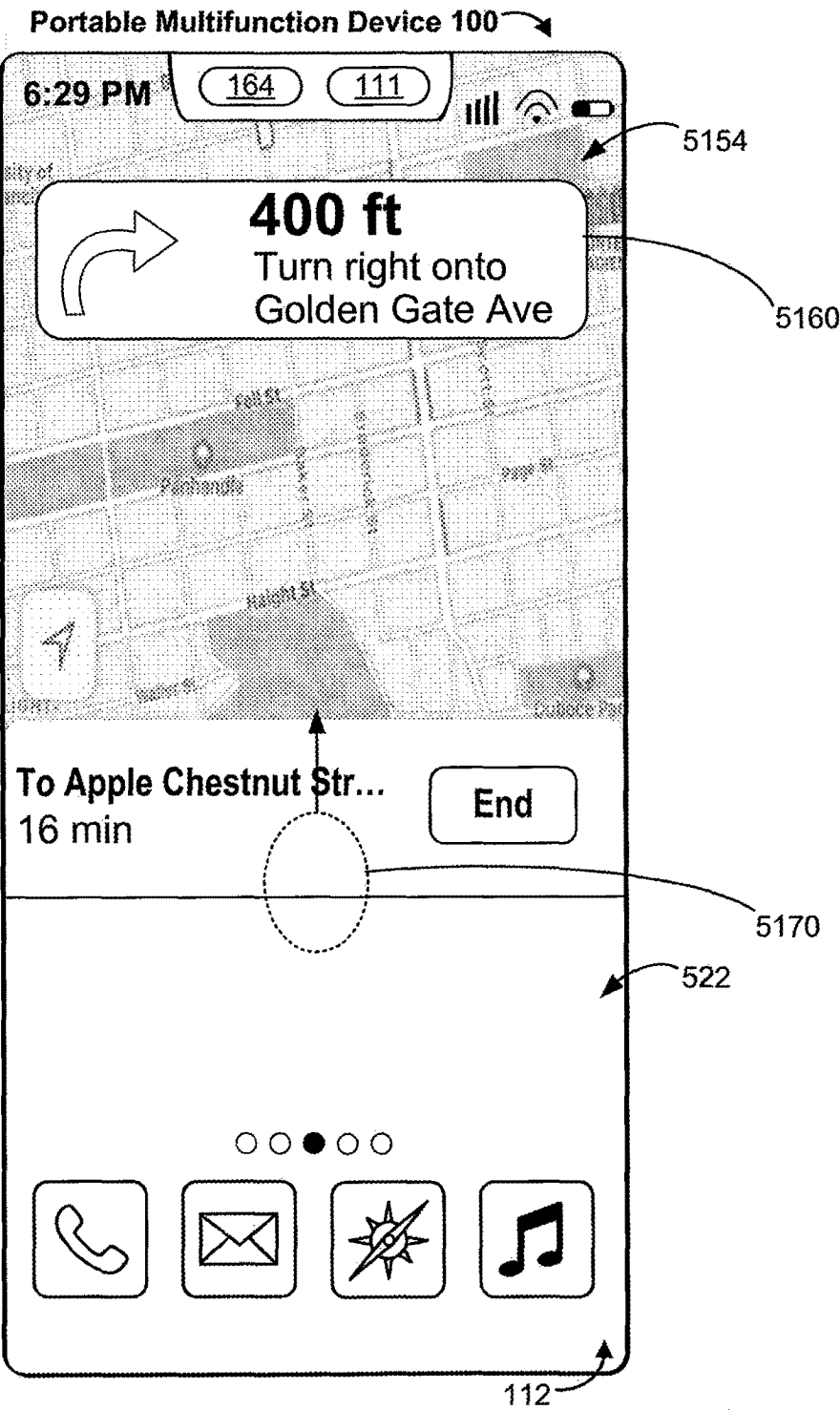


Figure 5DL

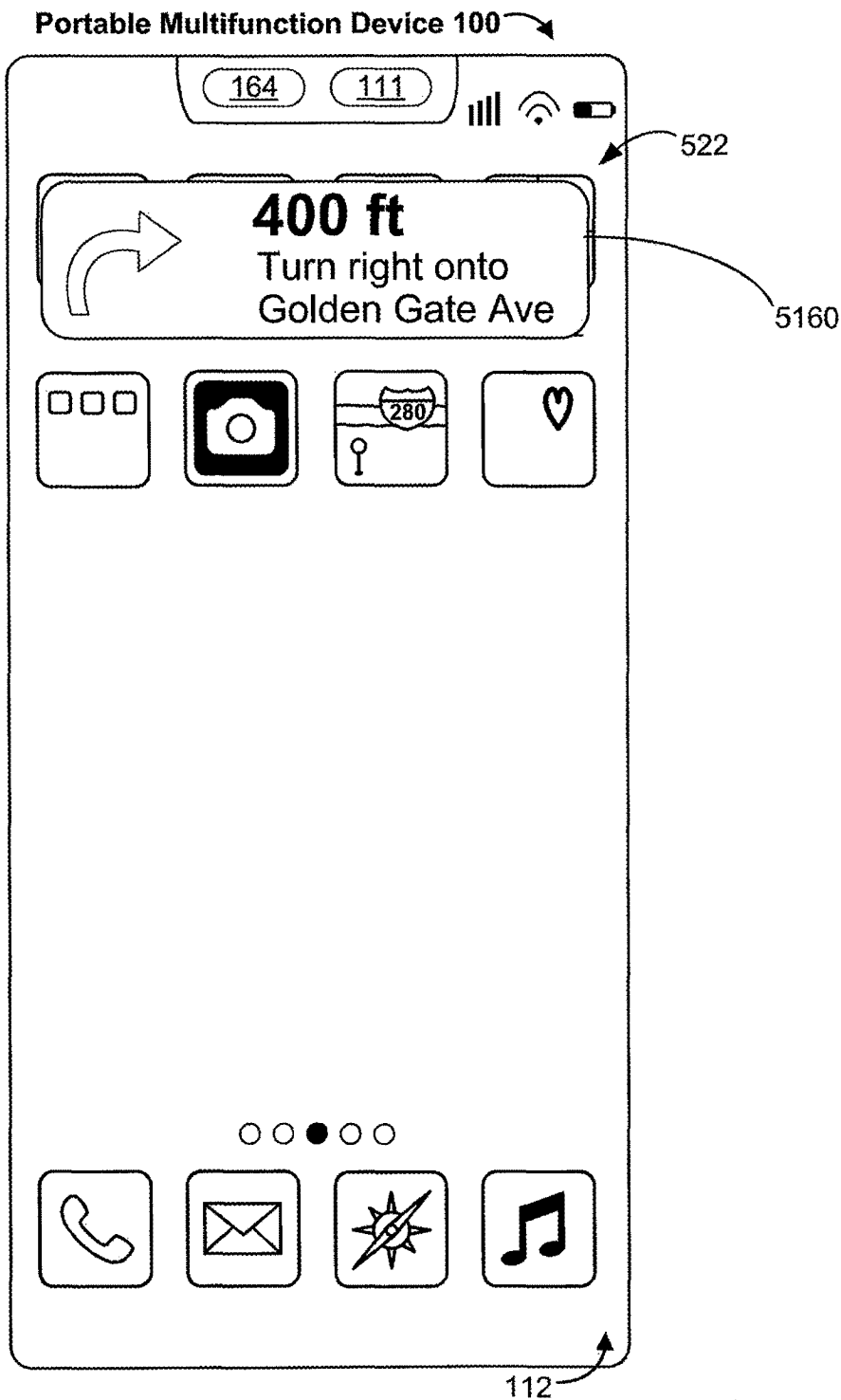


Figure 5DM



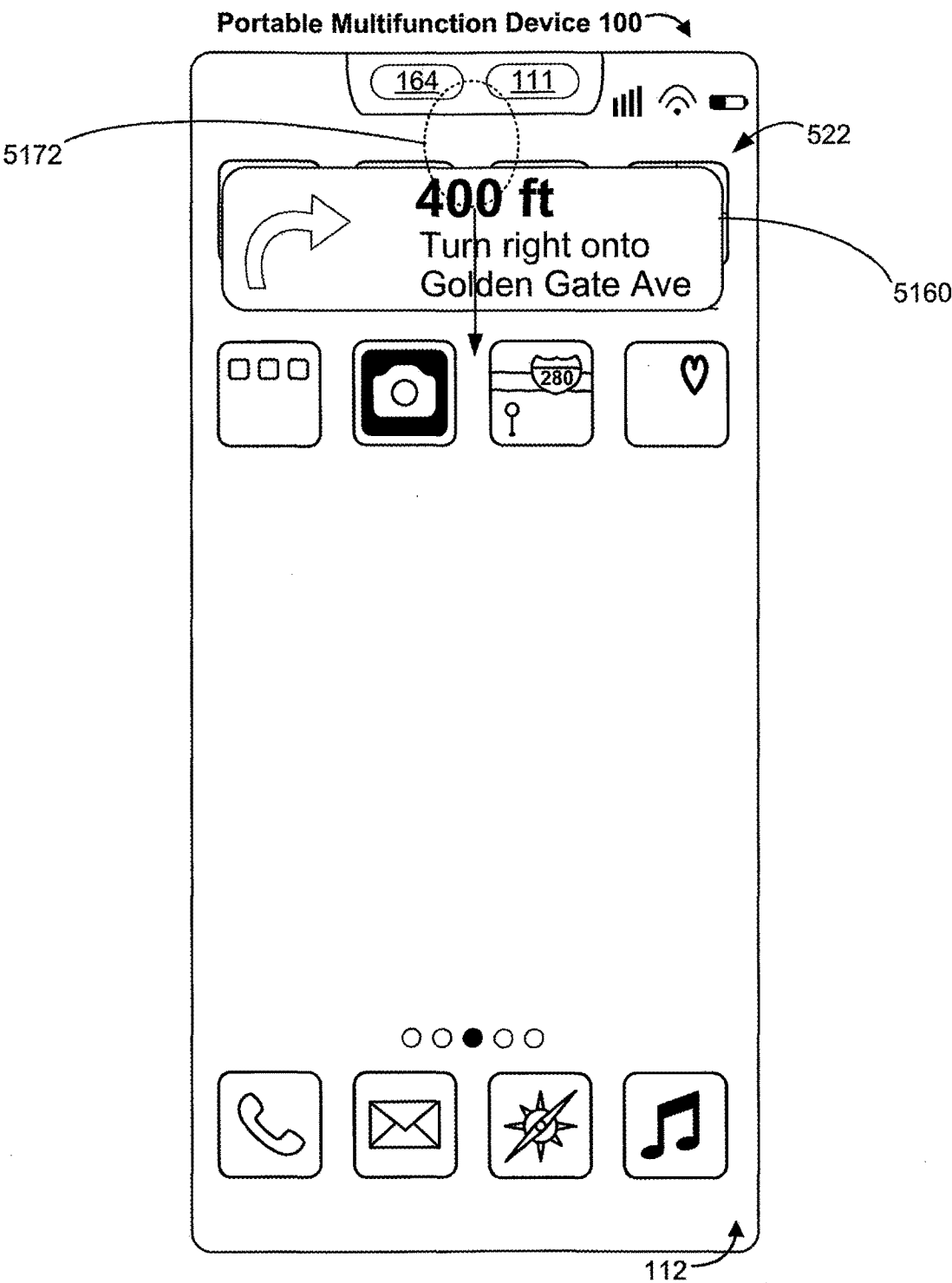


Figure 5DN

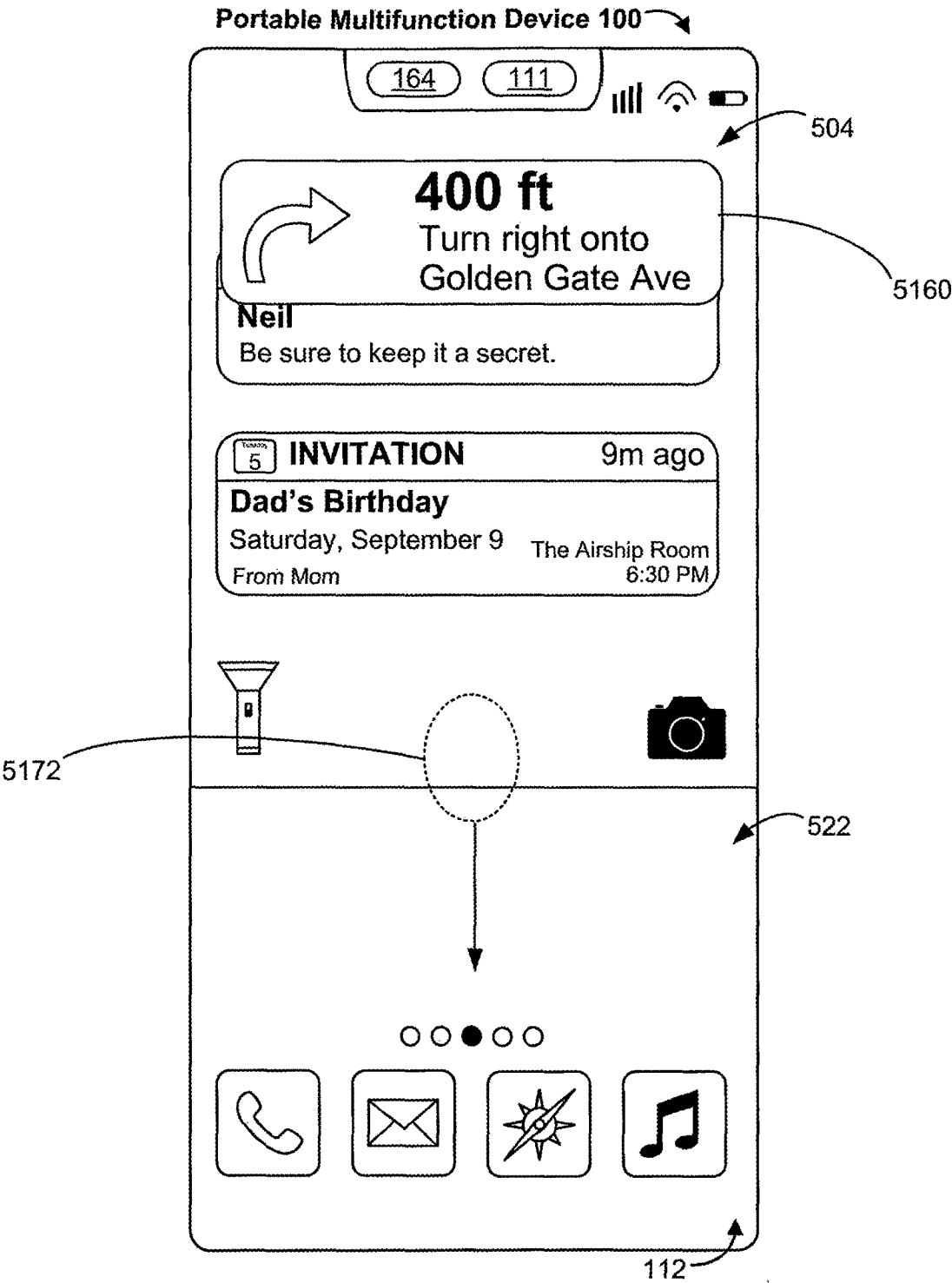


Figure 5DO



Figure 5DP

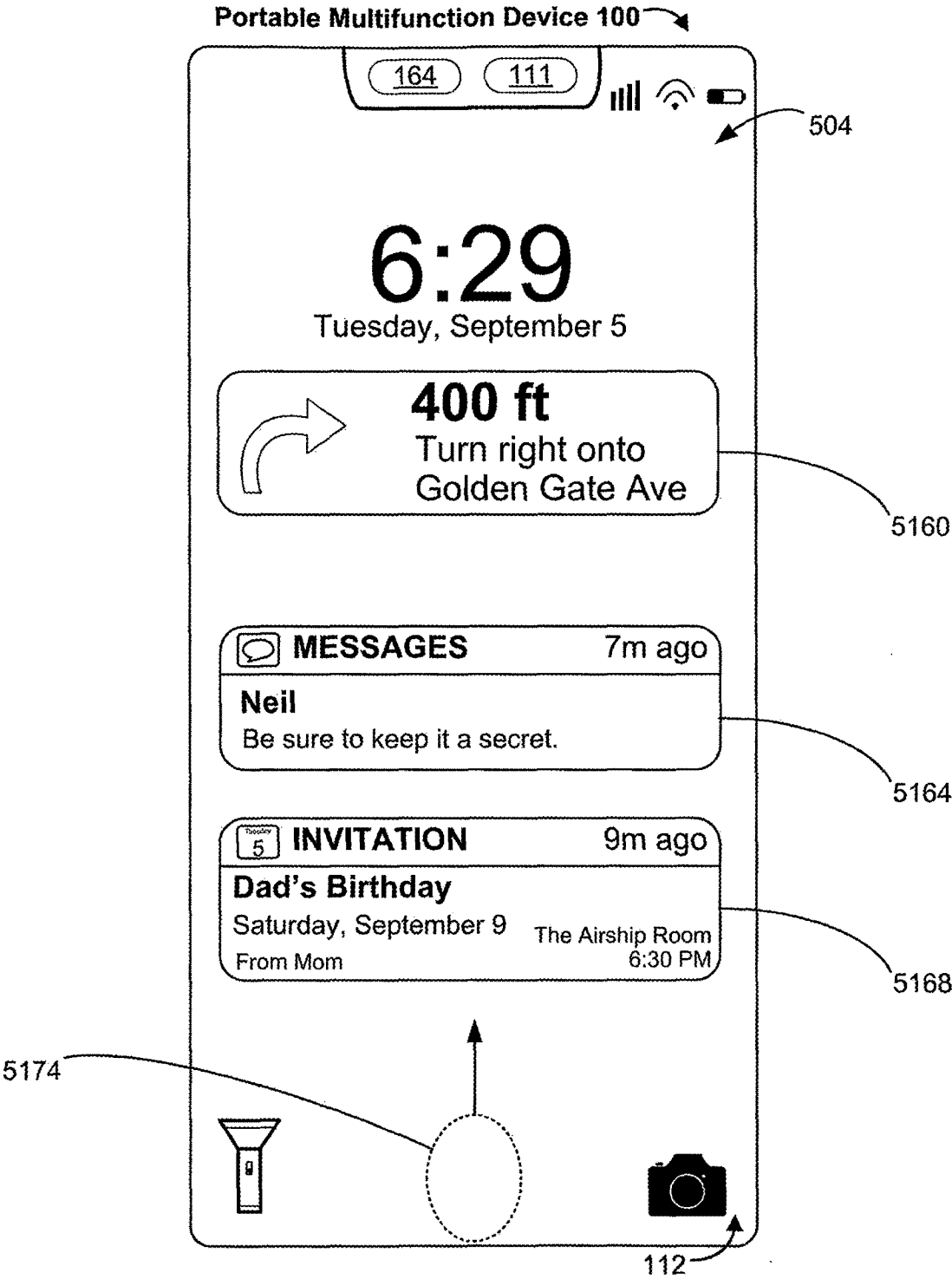


Figure 5DQ

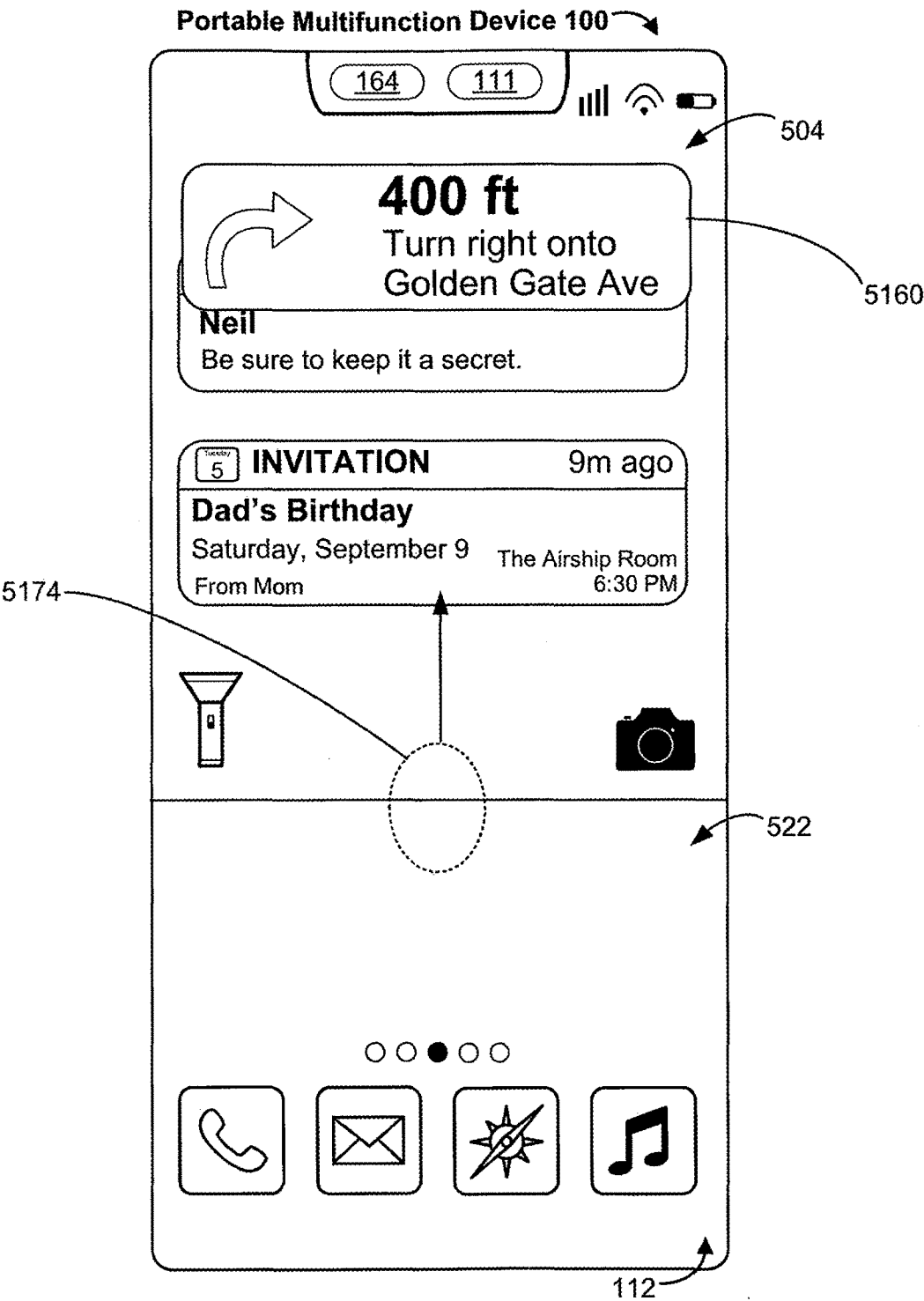


Figure 5DR



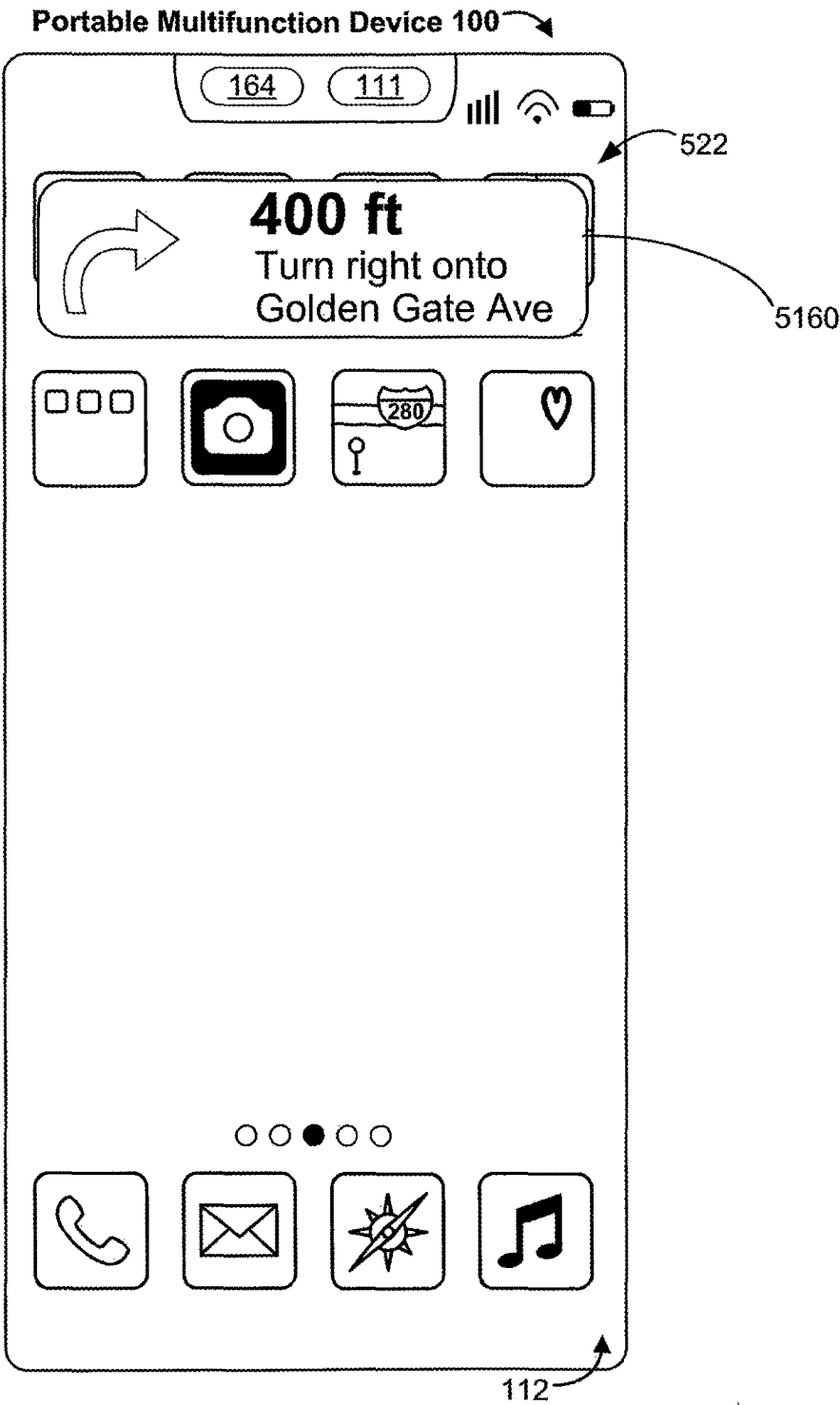


Figure 5DS

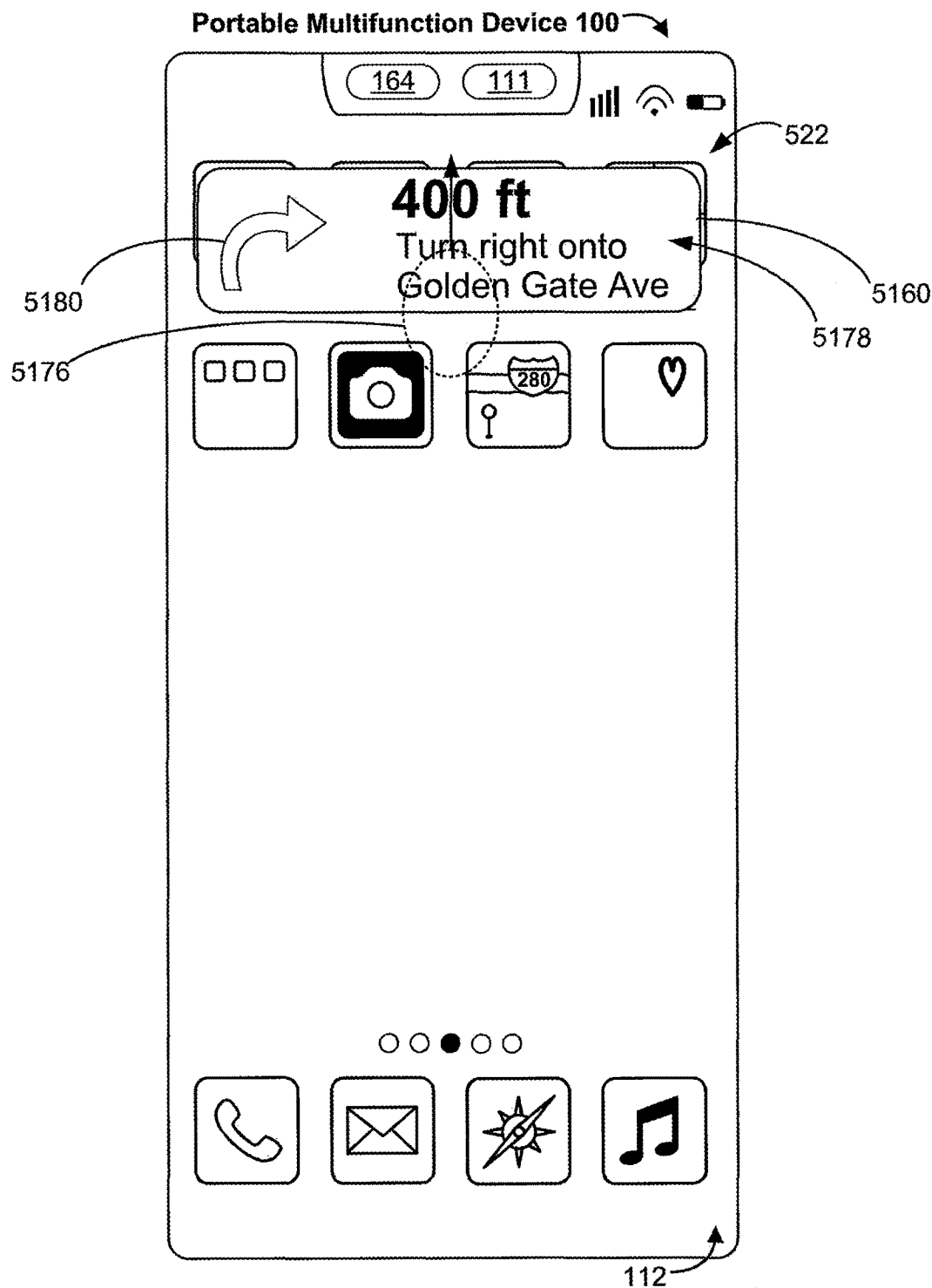


Figure 5DT

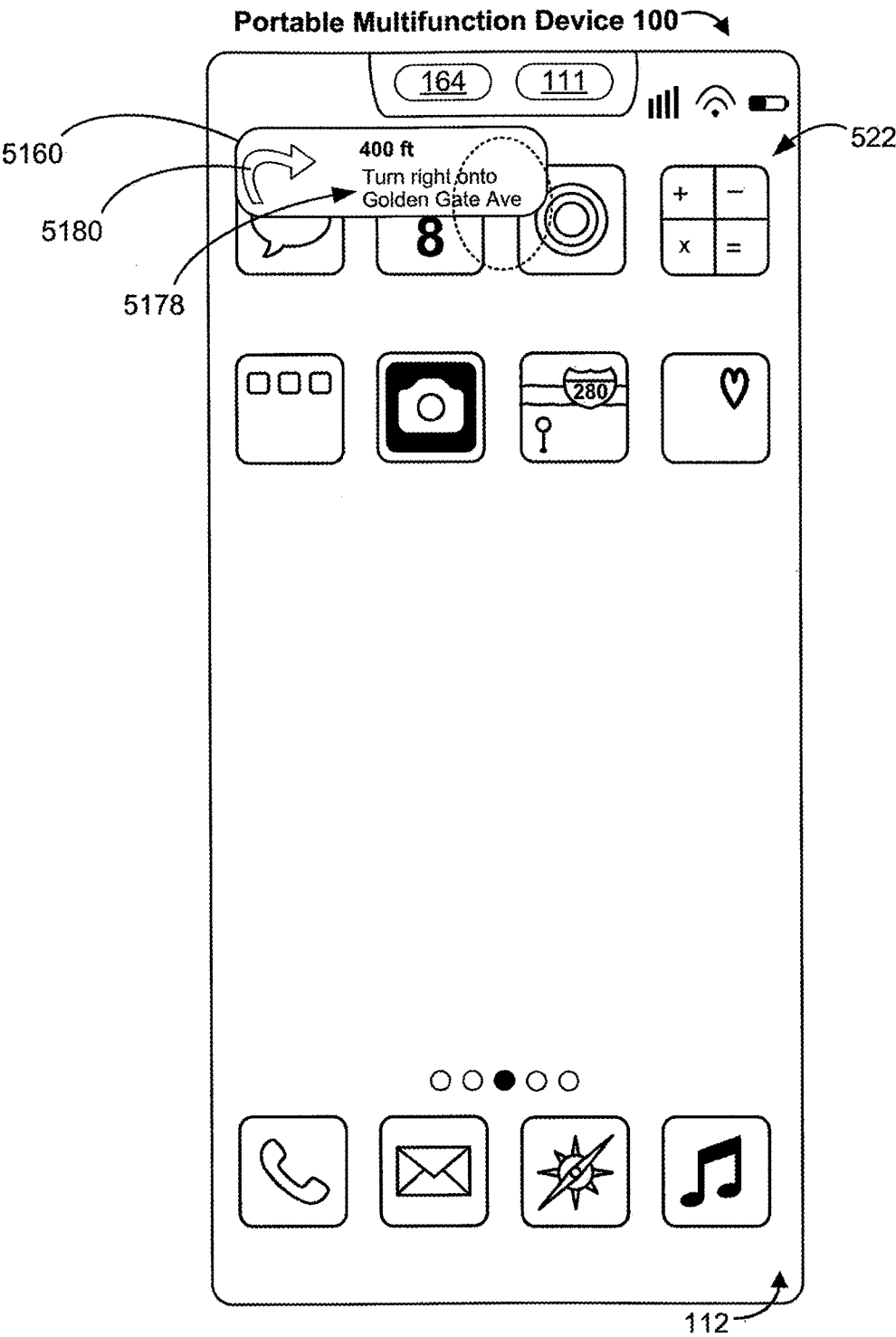


Figure 5DU

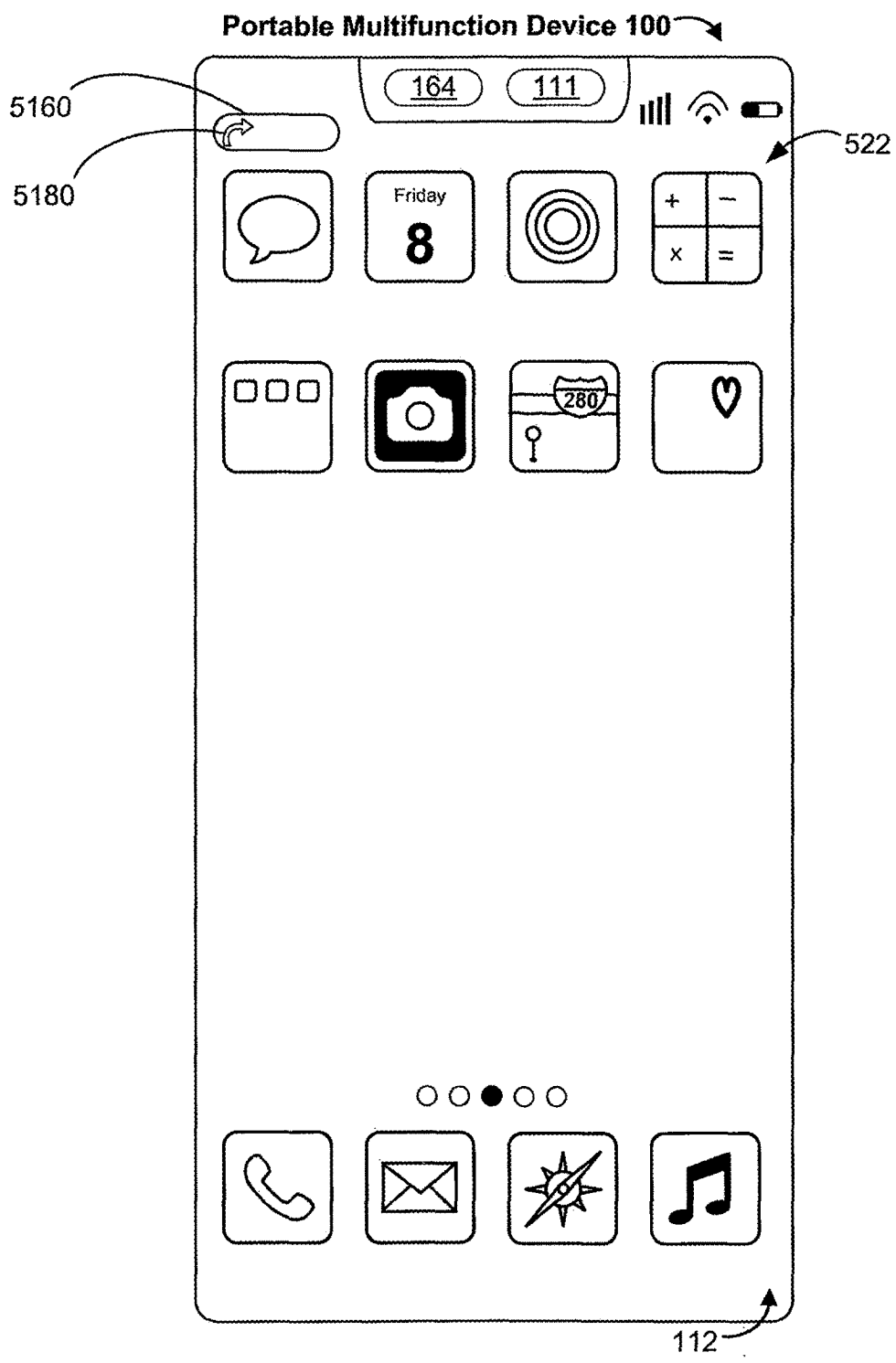


Figure 5DV

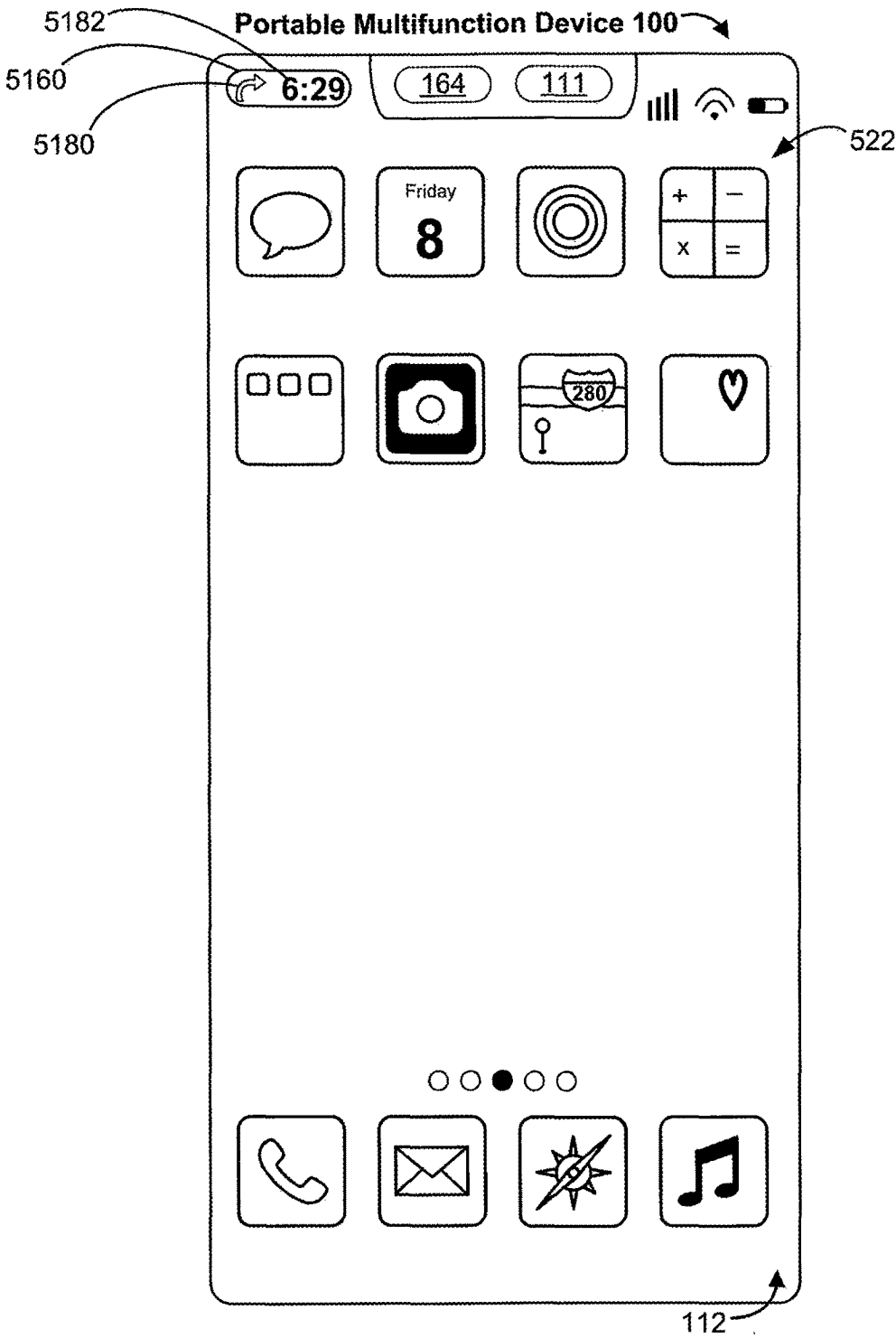


Figure 5DW



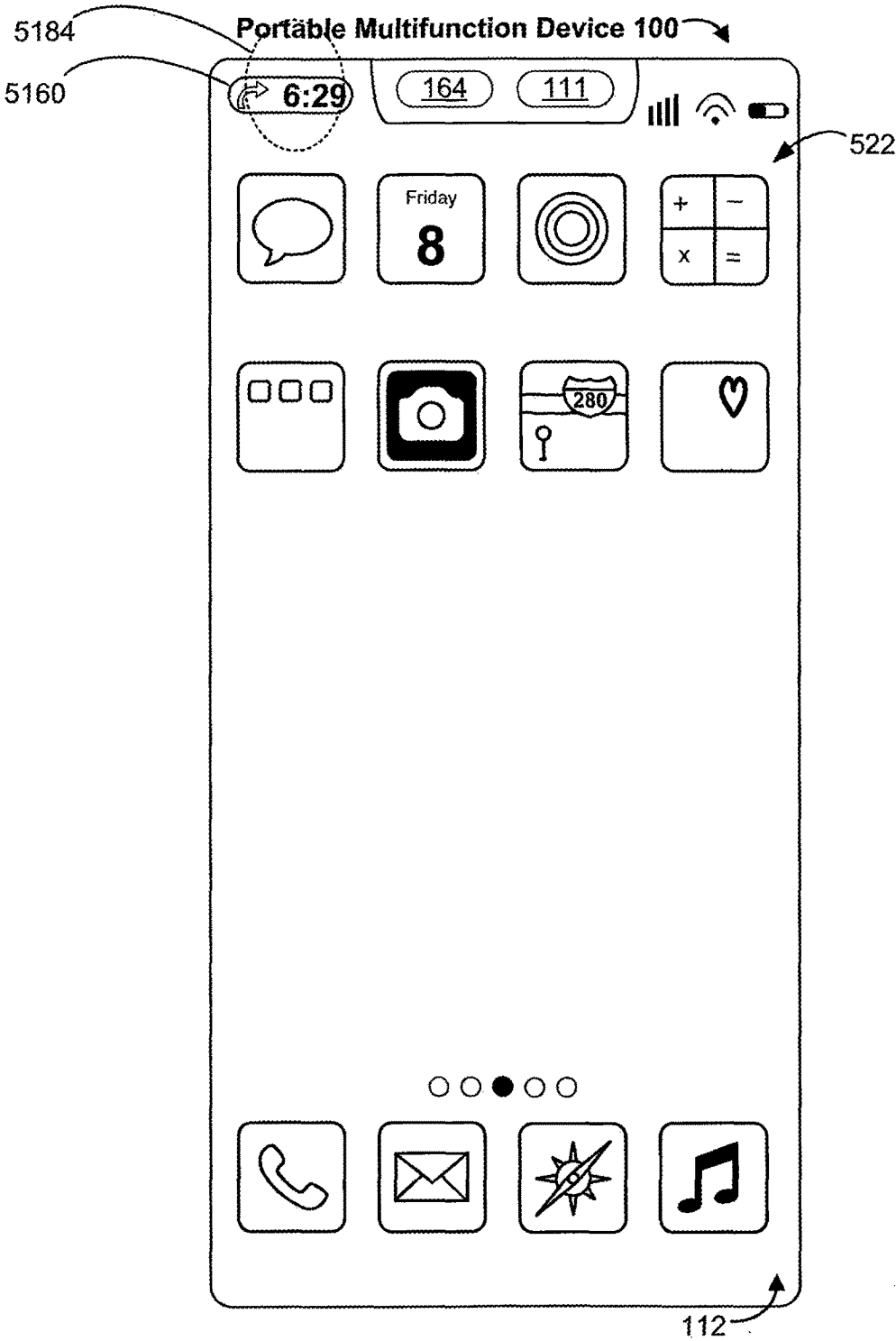


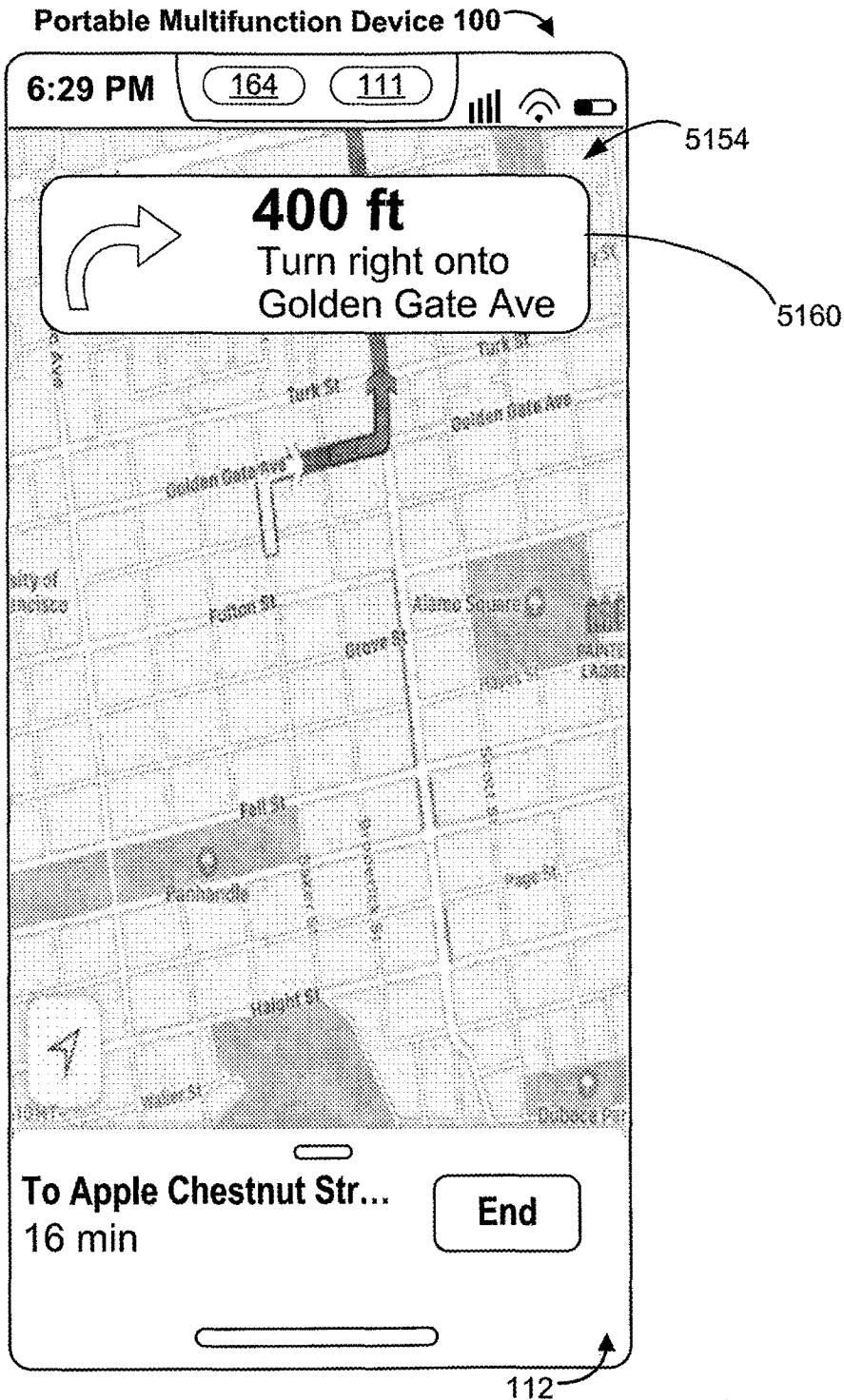
Figure 5DX

## U.S. Patent

**Aug. 31, 2021**

Sheet 139 of 253

US 11,106,352 B2



### Figure 5DY

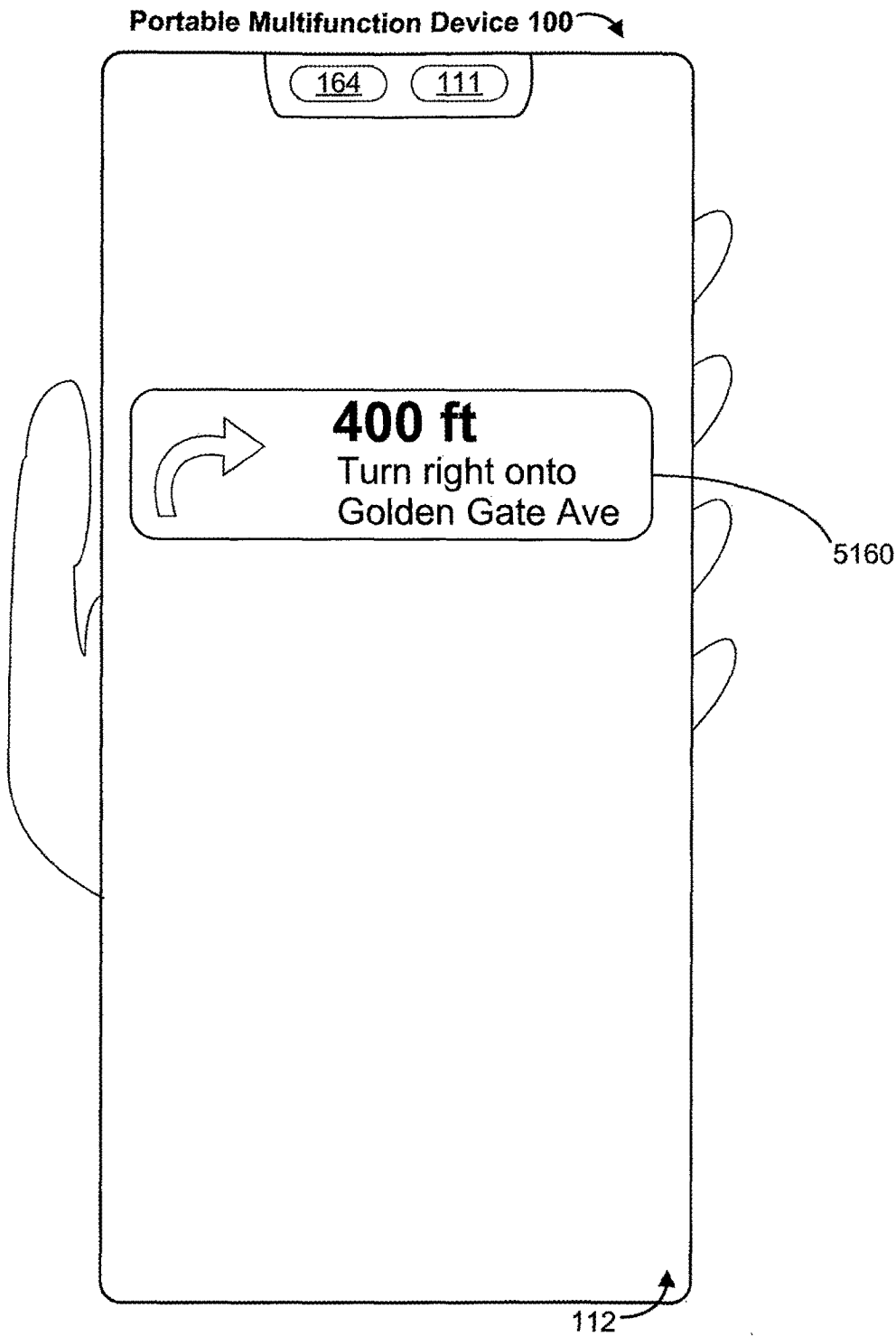


Figure 5DZ

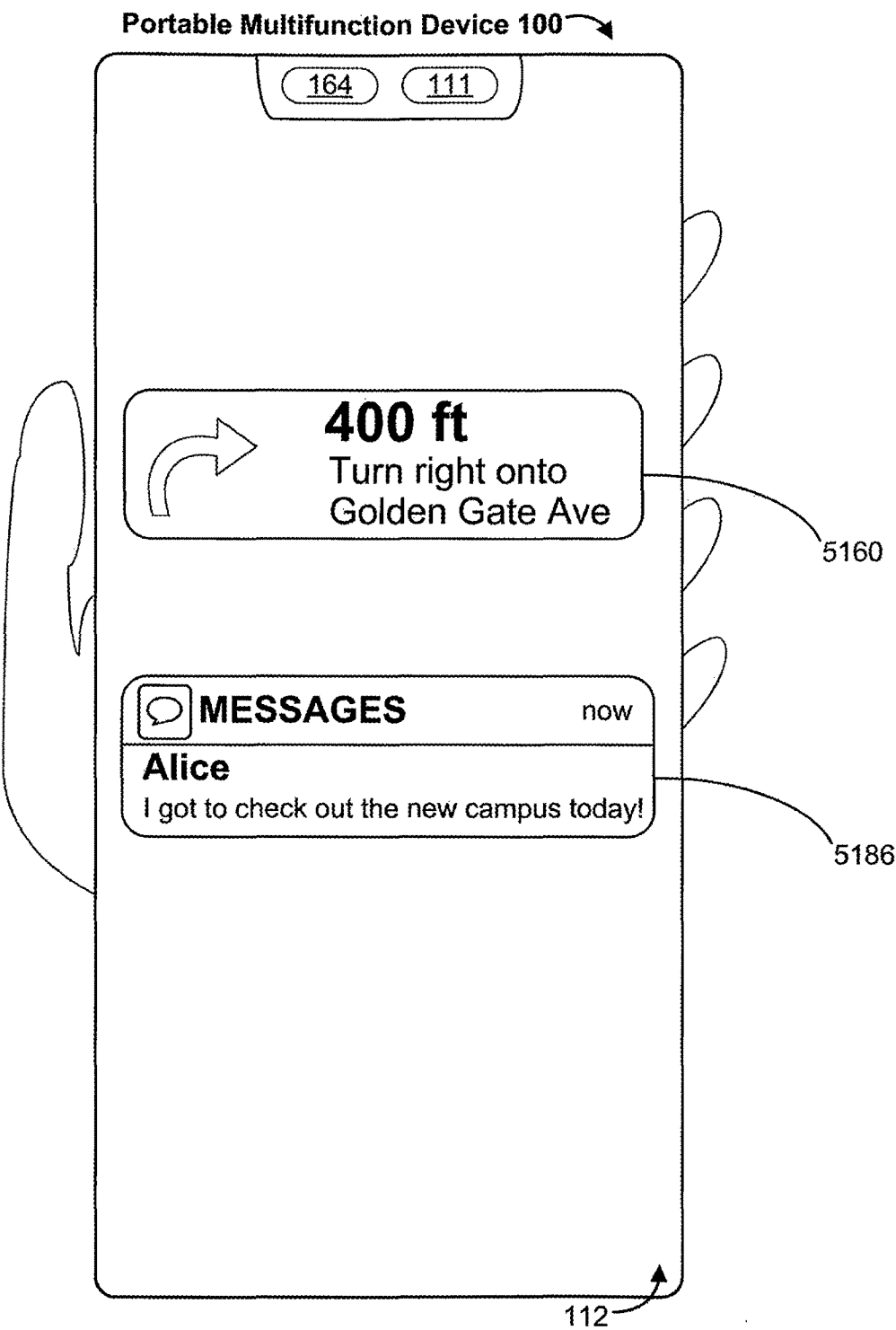


Figure 5EA

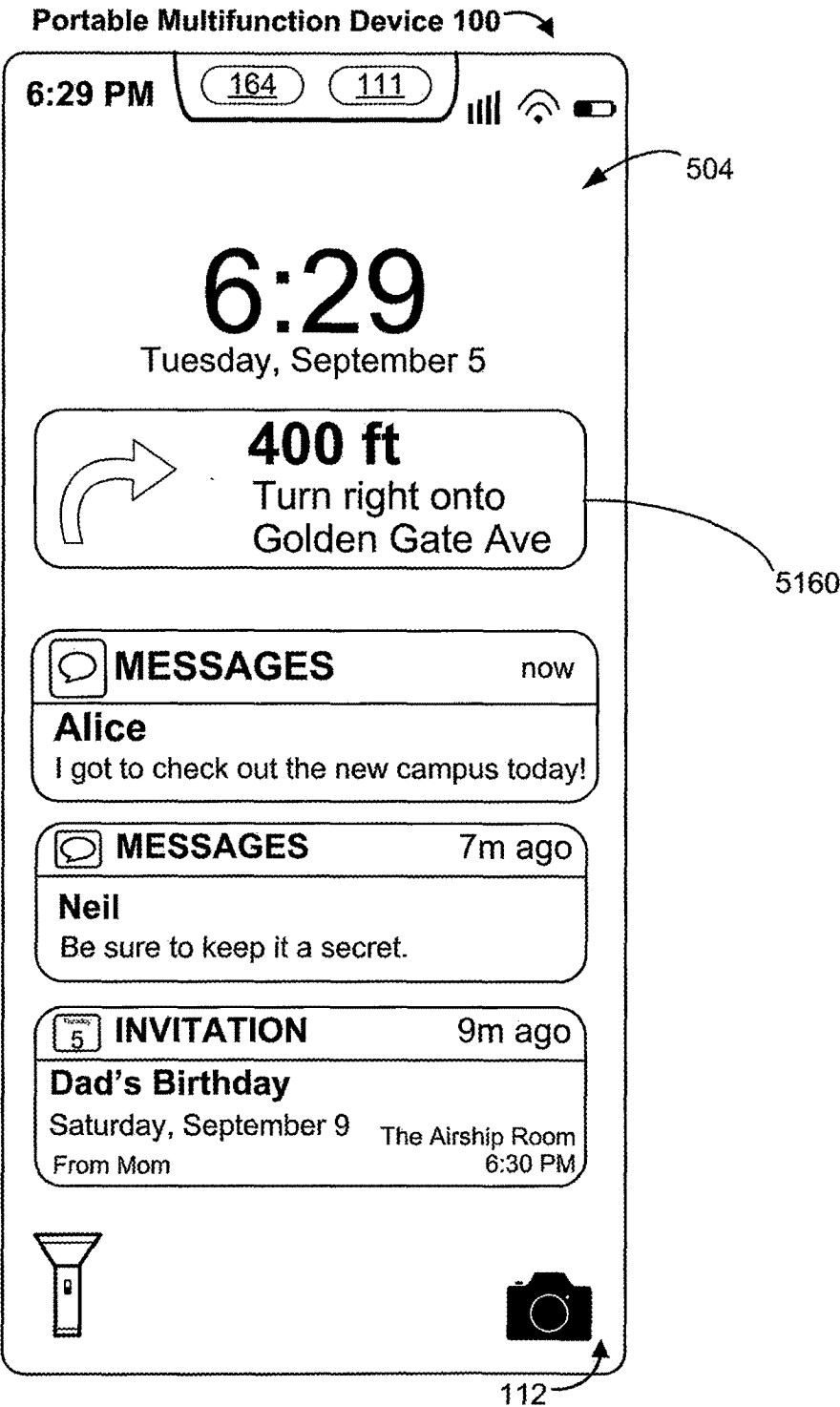


Figure 5EB

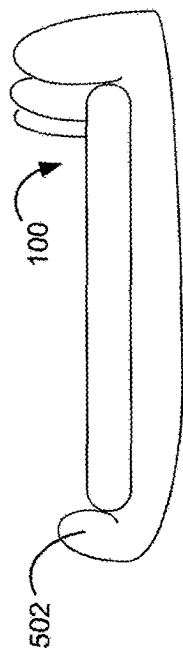


Figure 5EC1

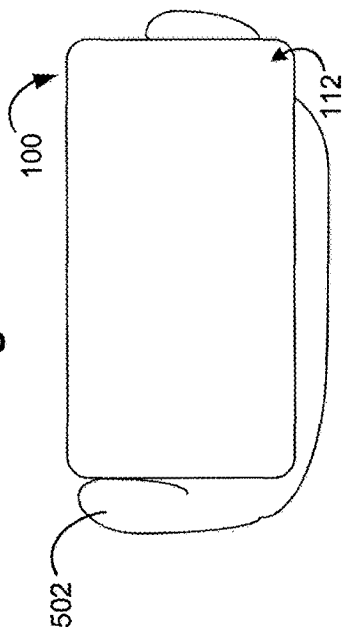


Figure 5EC2

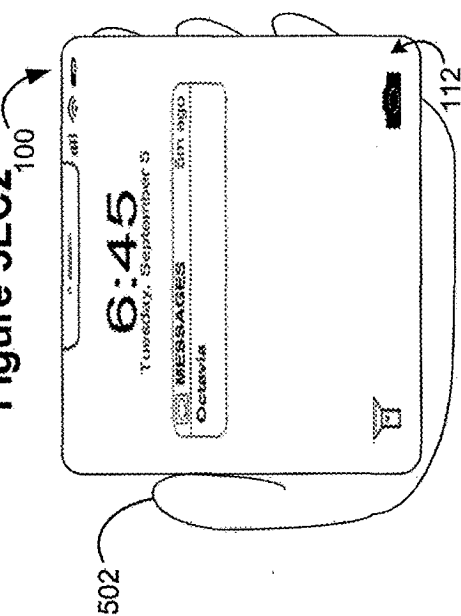


Figure 5EC3

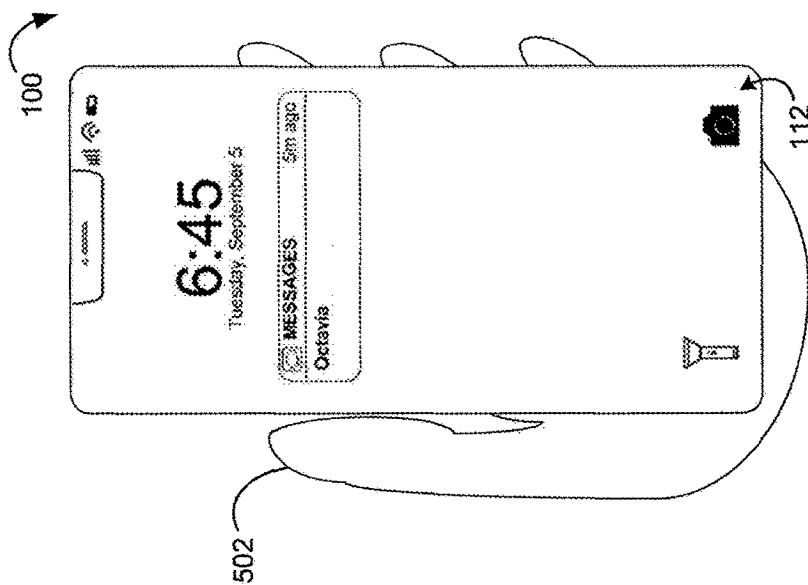


Figure 5EC4

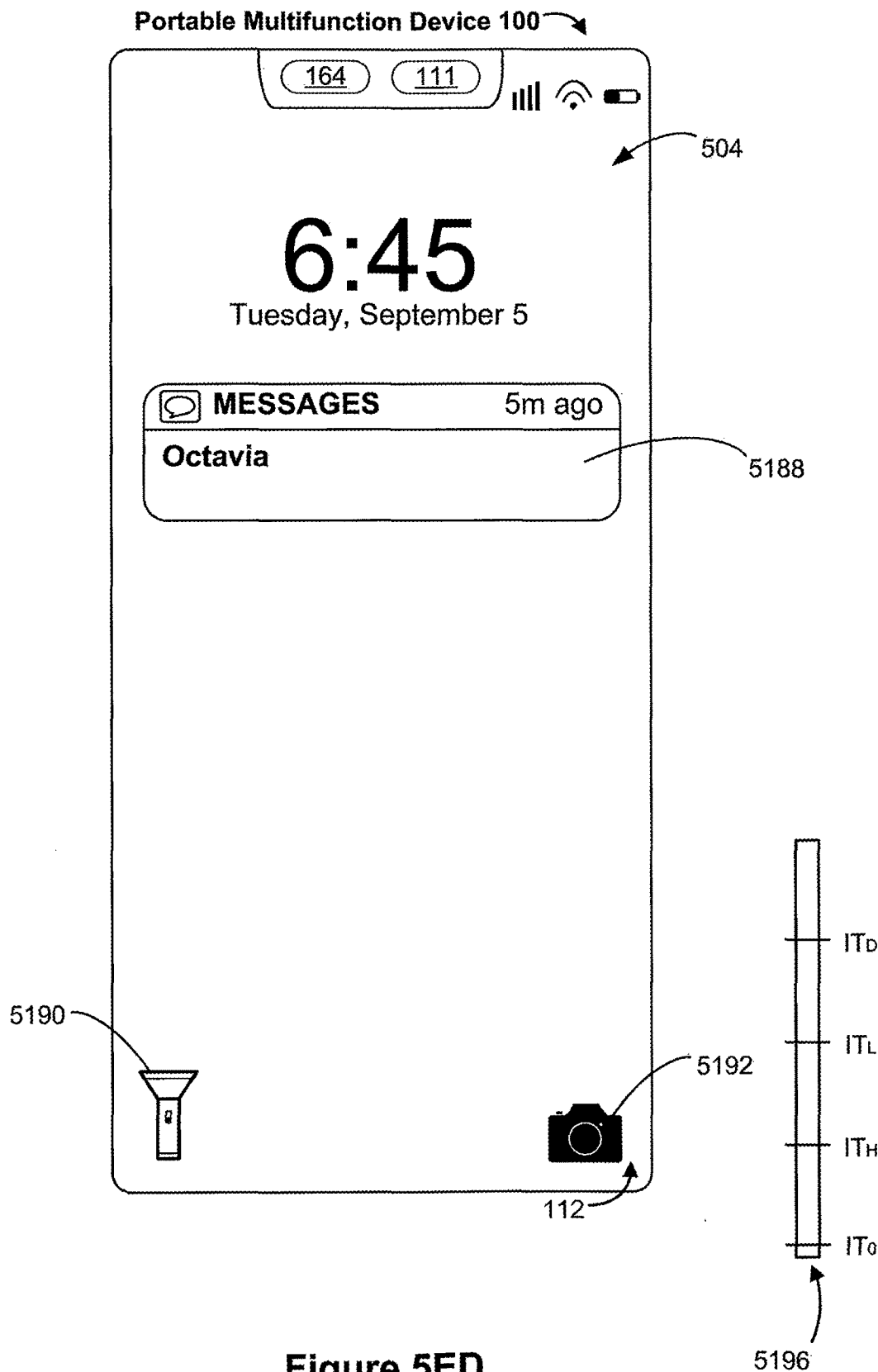


Figure 5ED

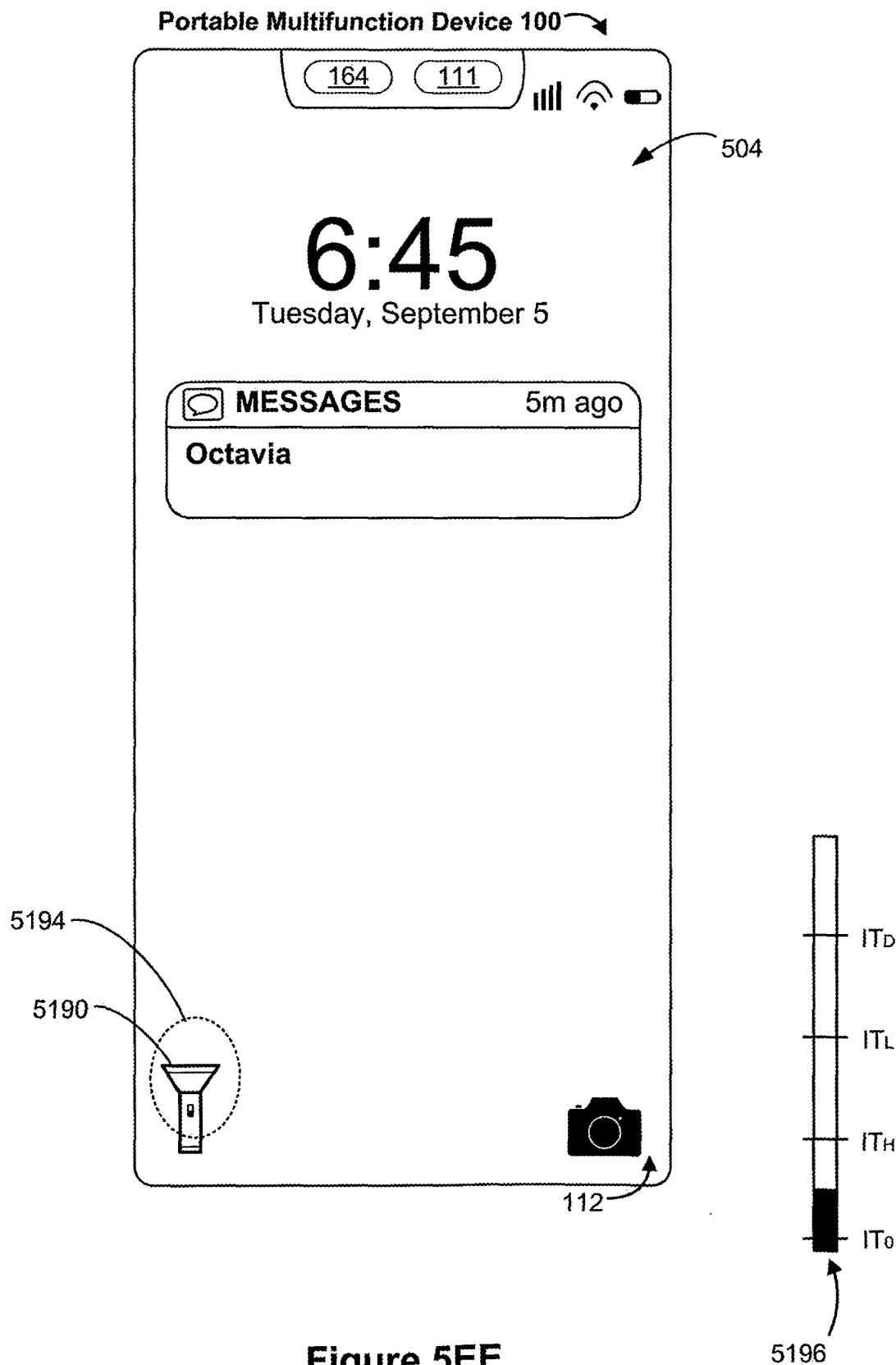


Figure 5EE



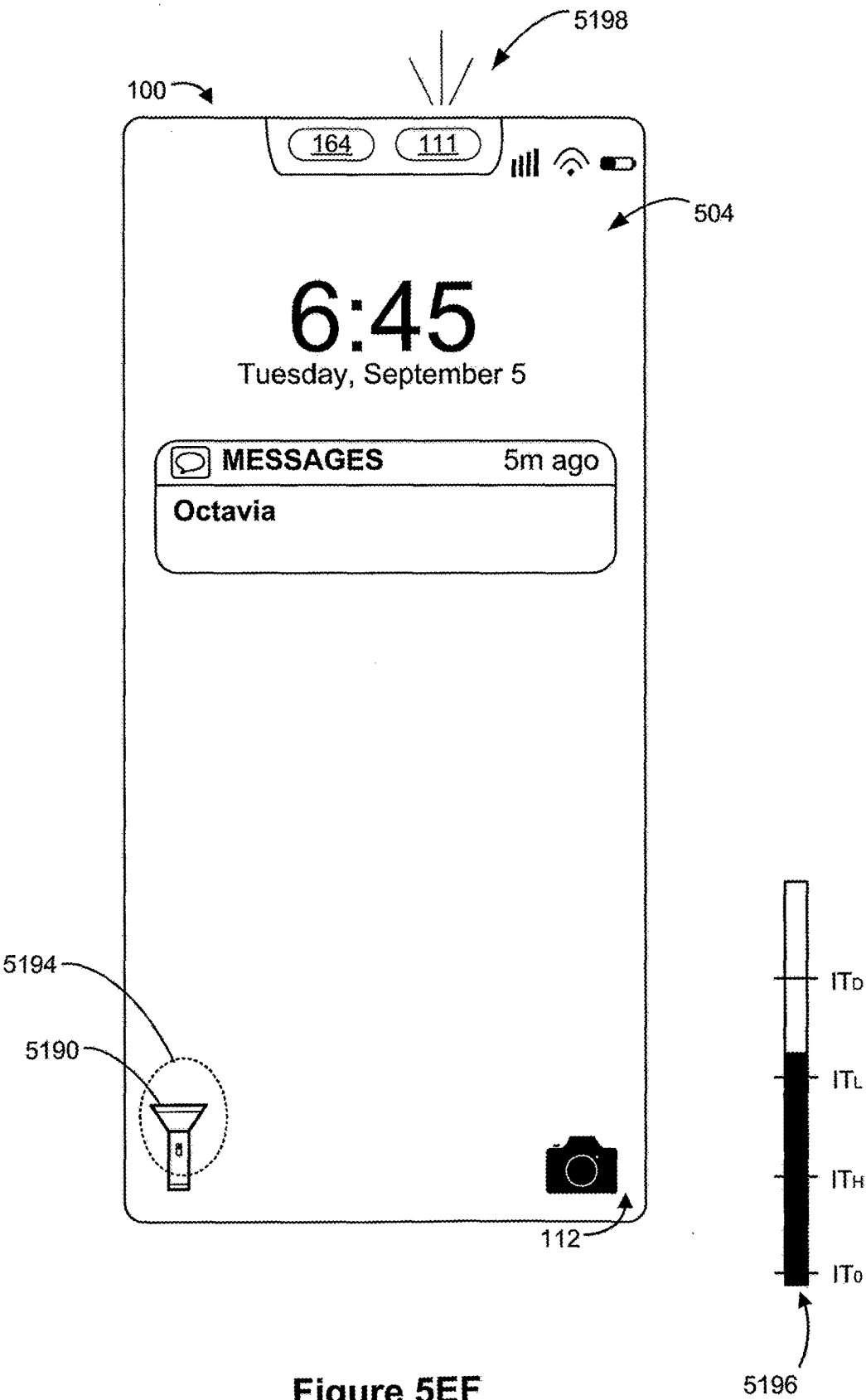


Figure 5EF

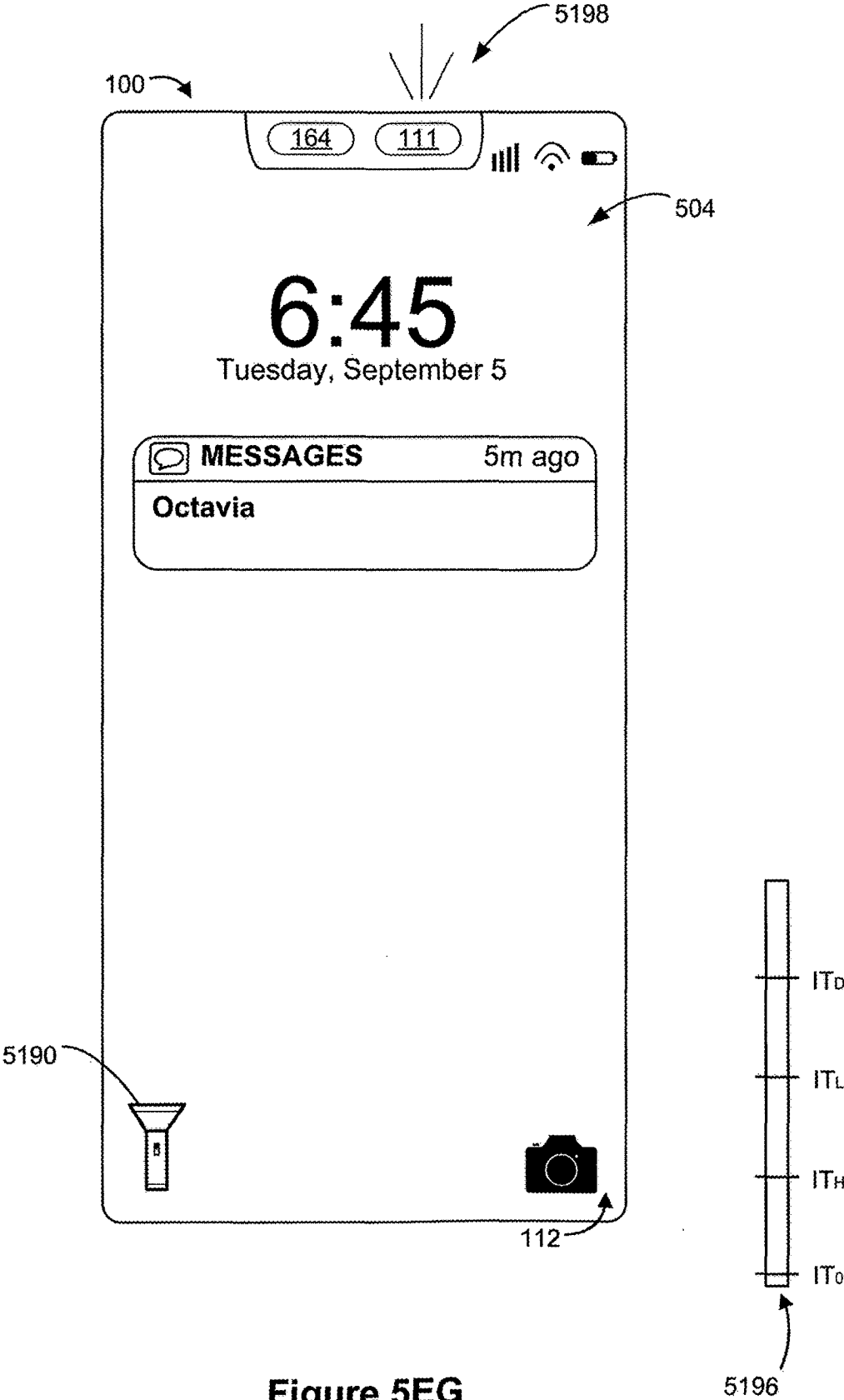


Figure 5EG

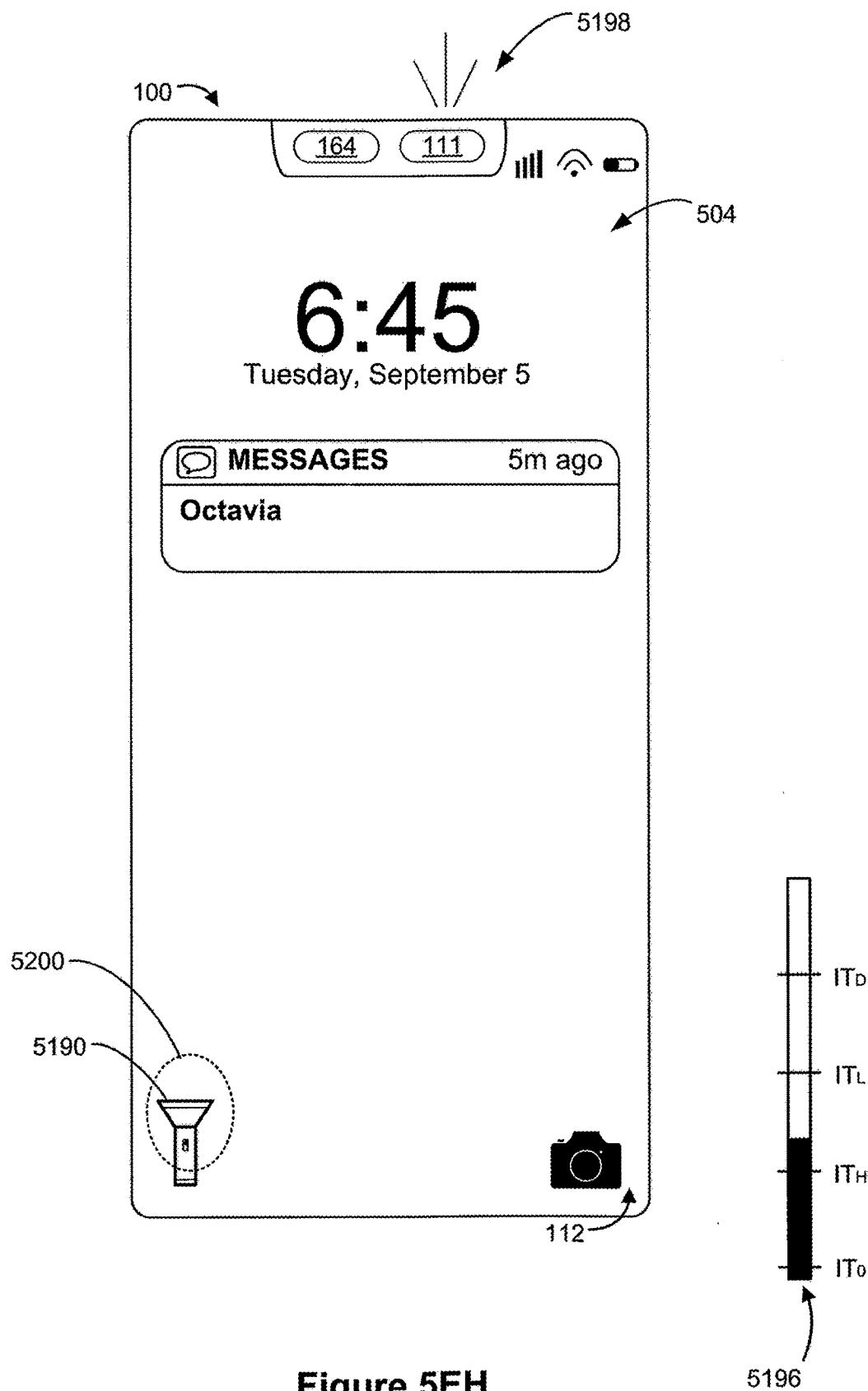


Figure 5EH

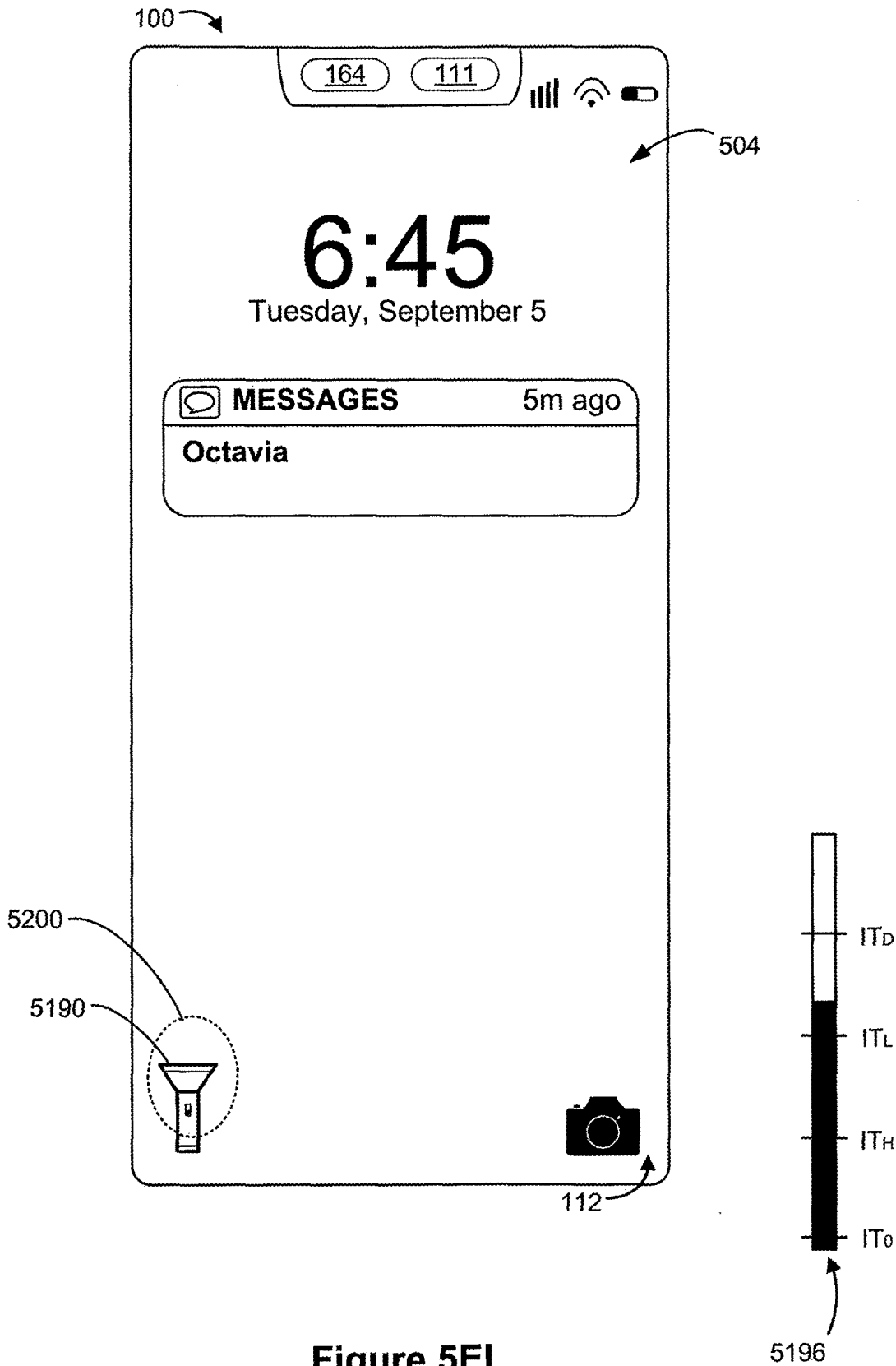


Figure 5E

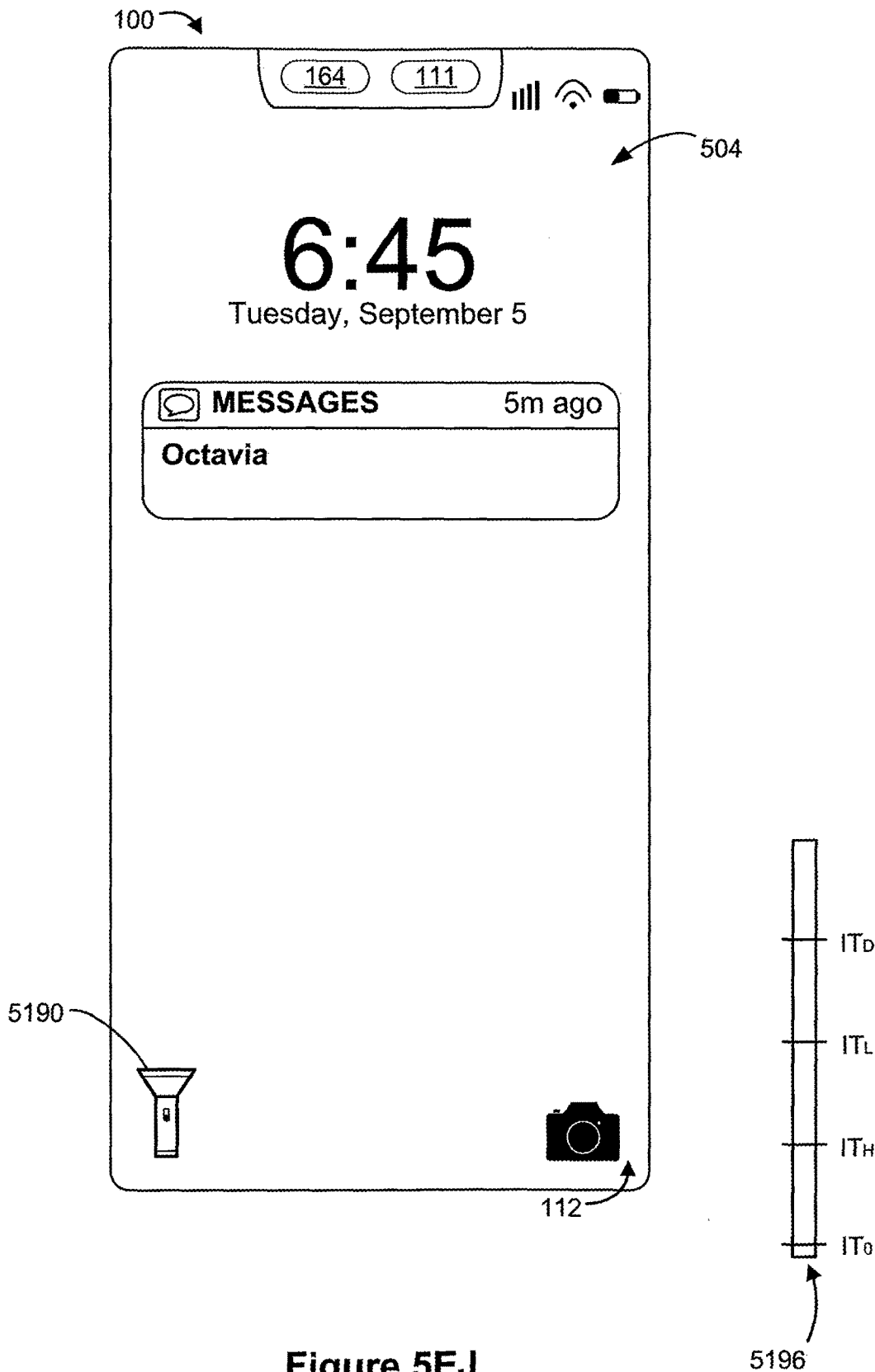


Figure 5EJ

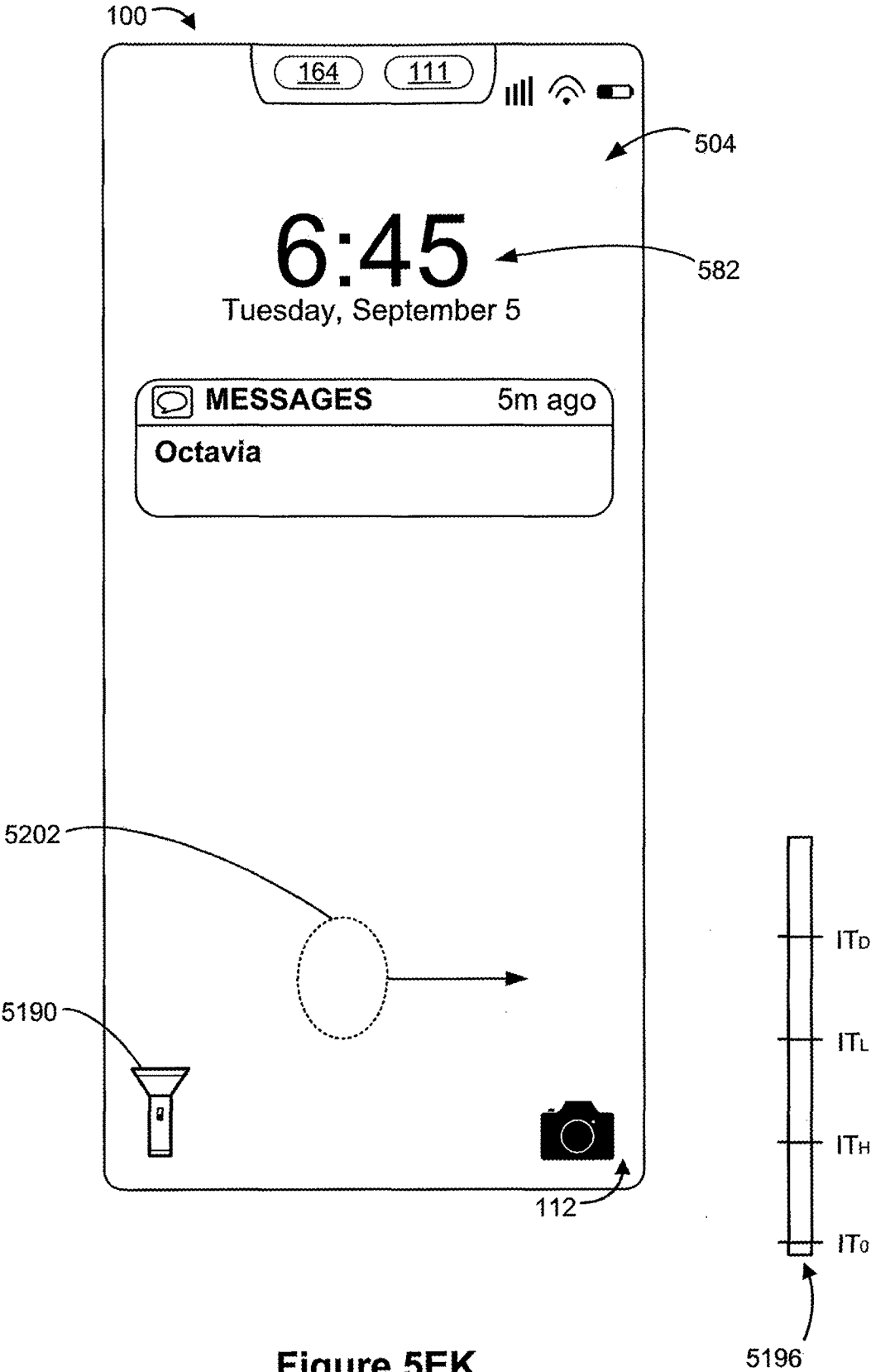
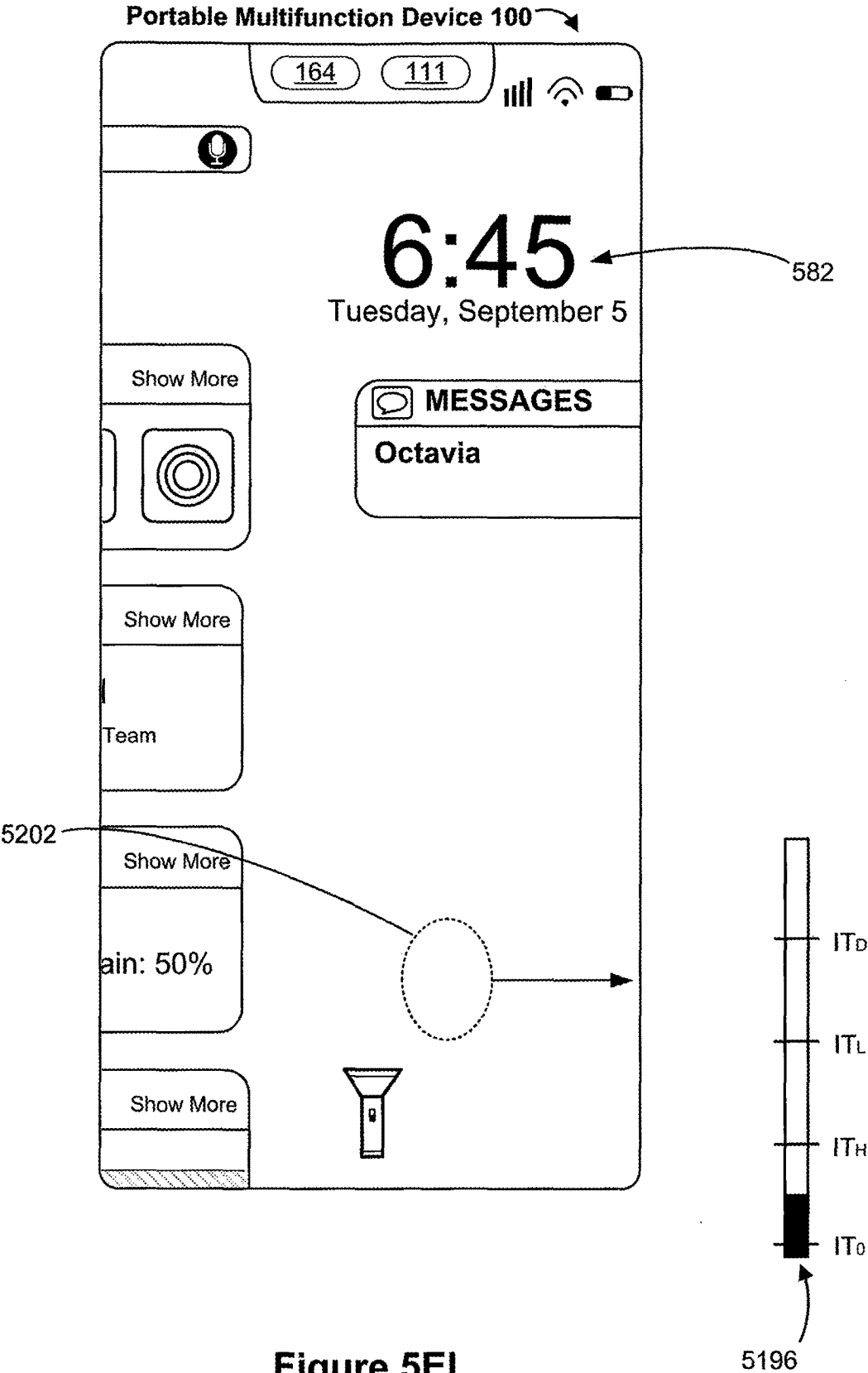
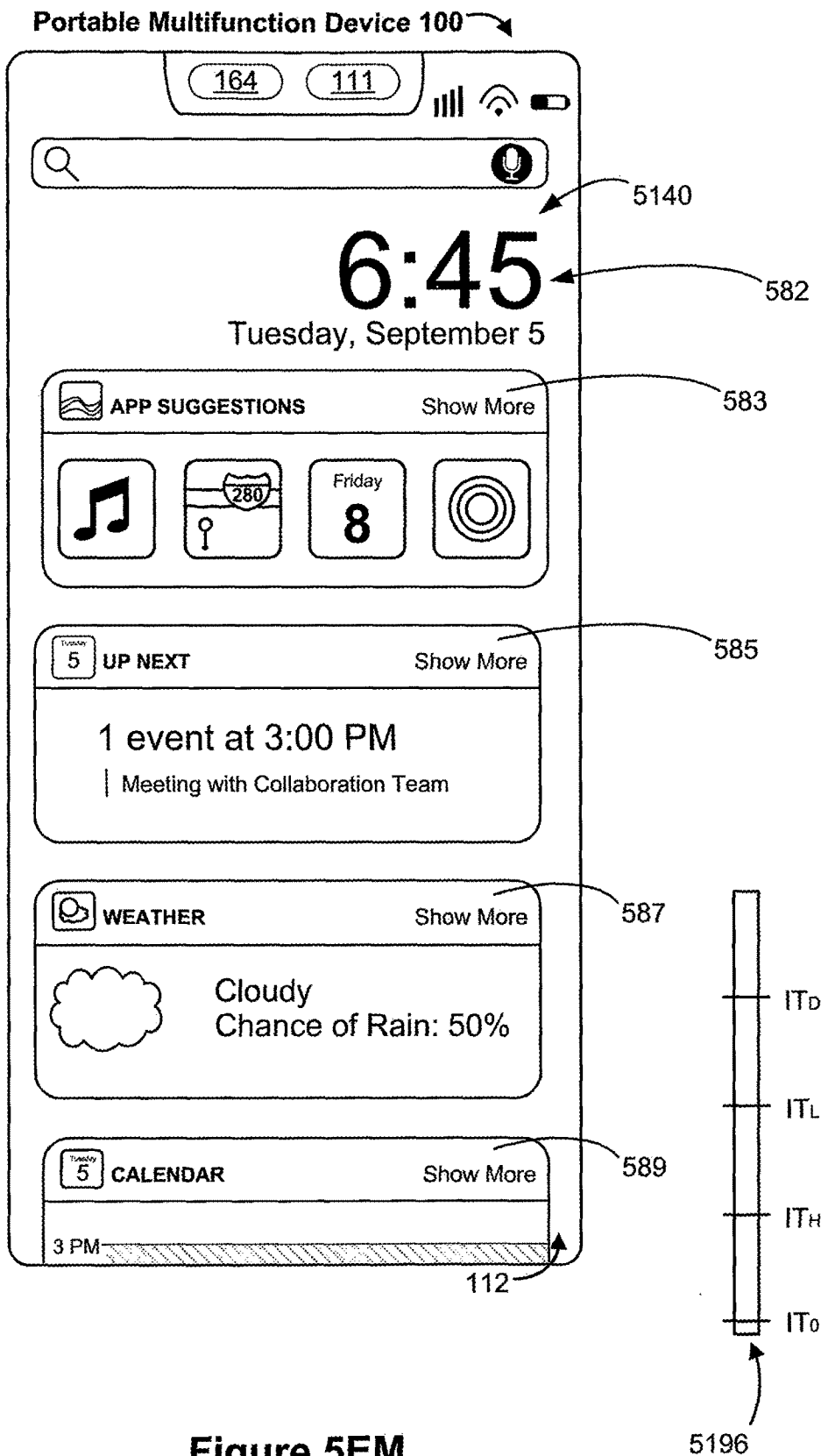


Figure 5EK







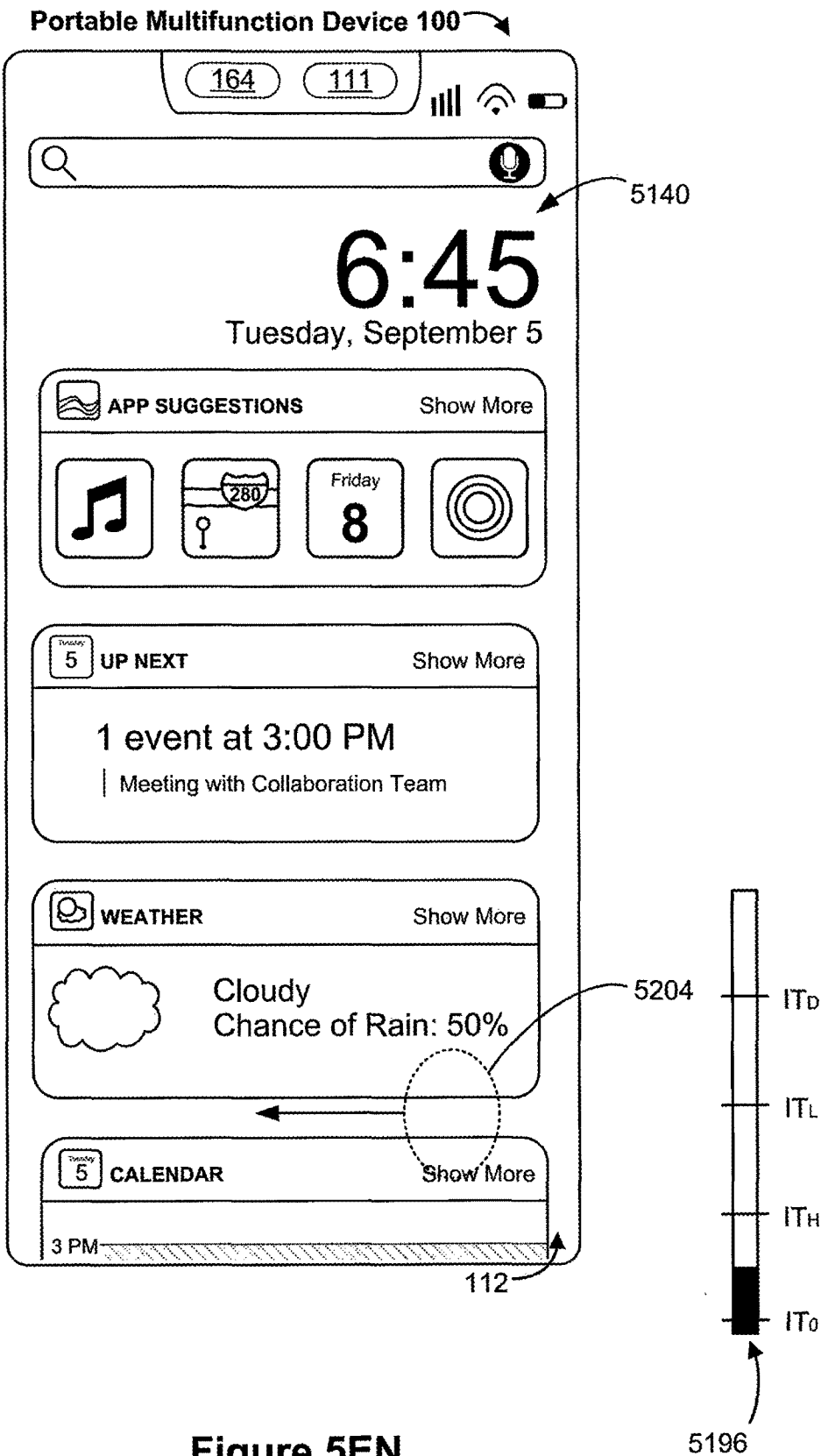
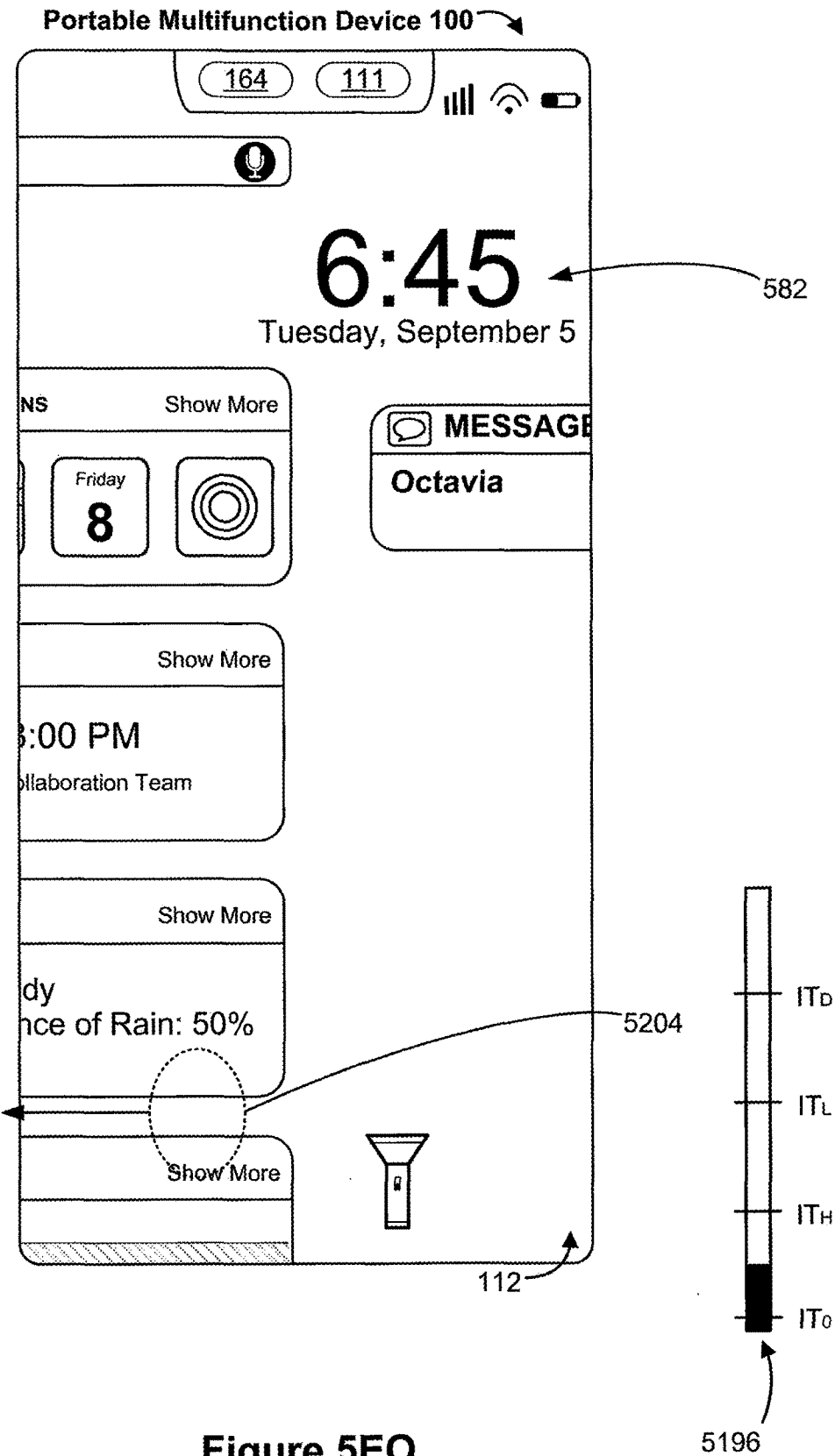


Figure 5EN



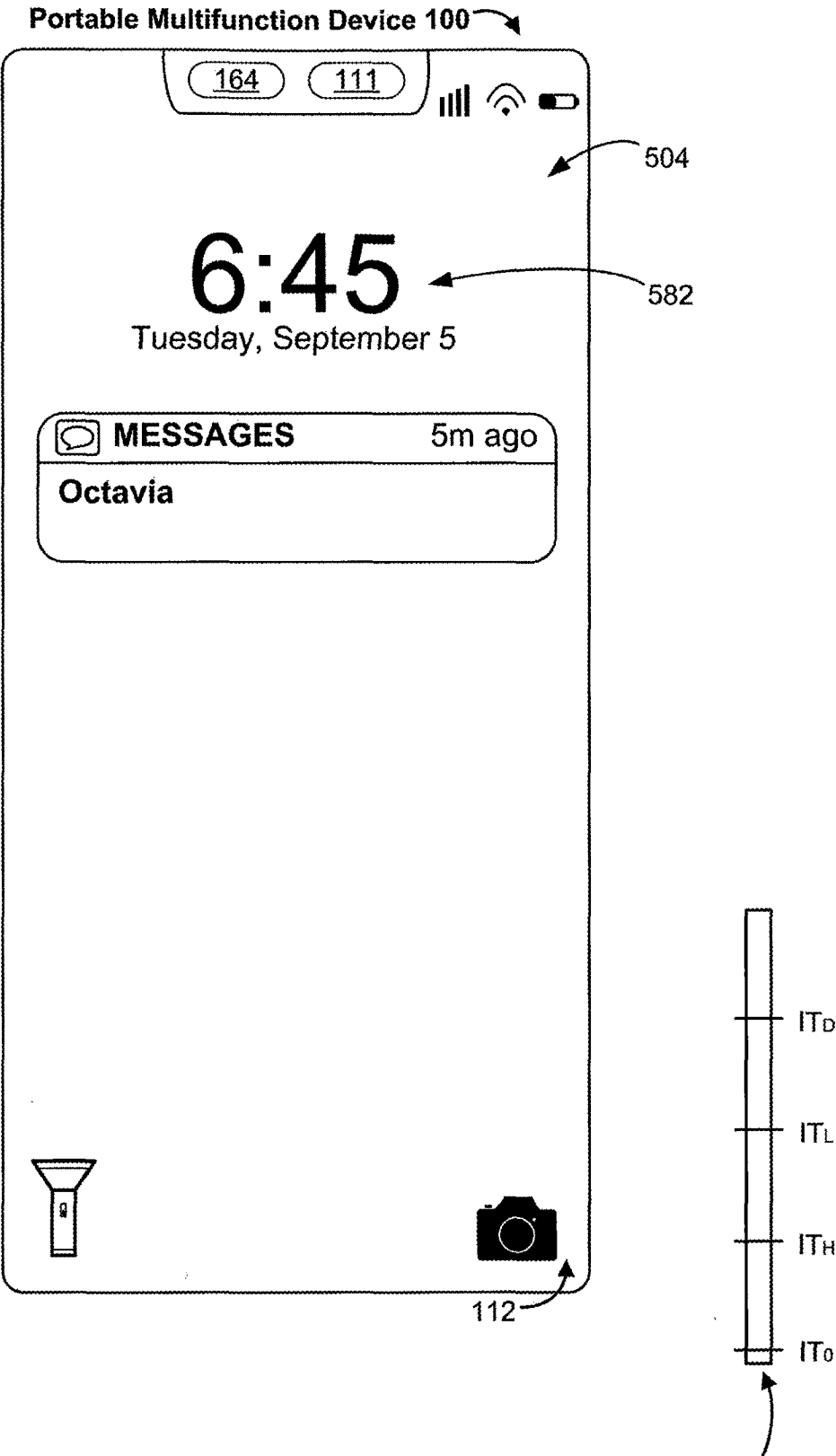


Figure 5EP

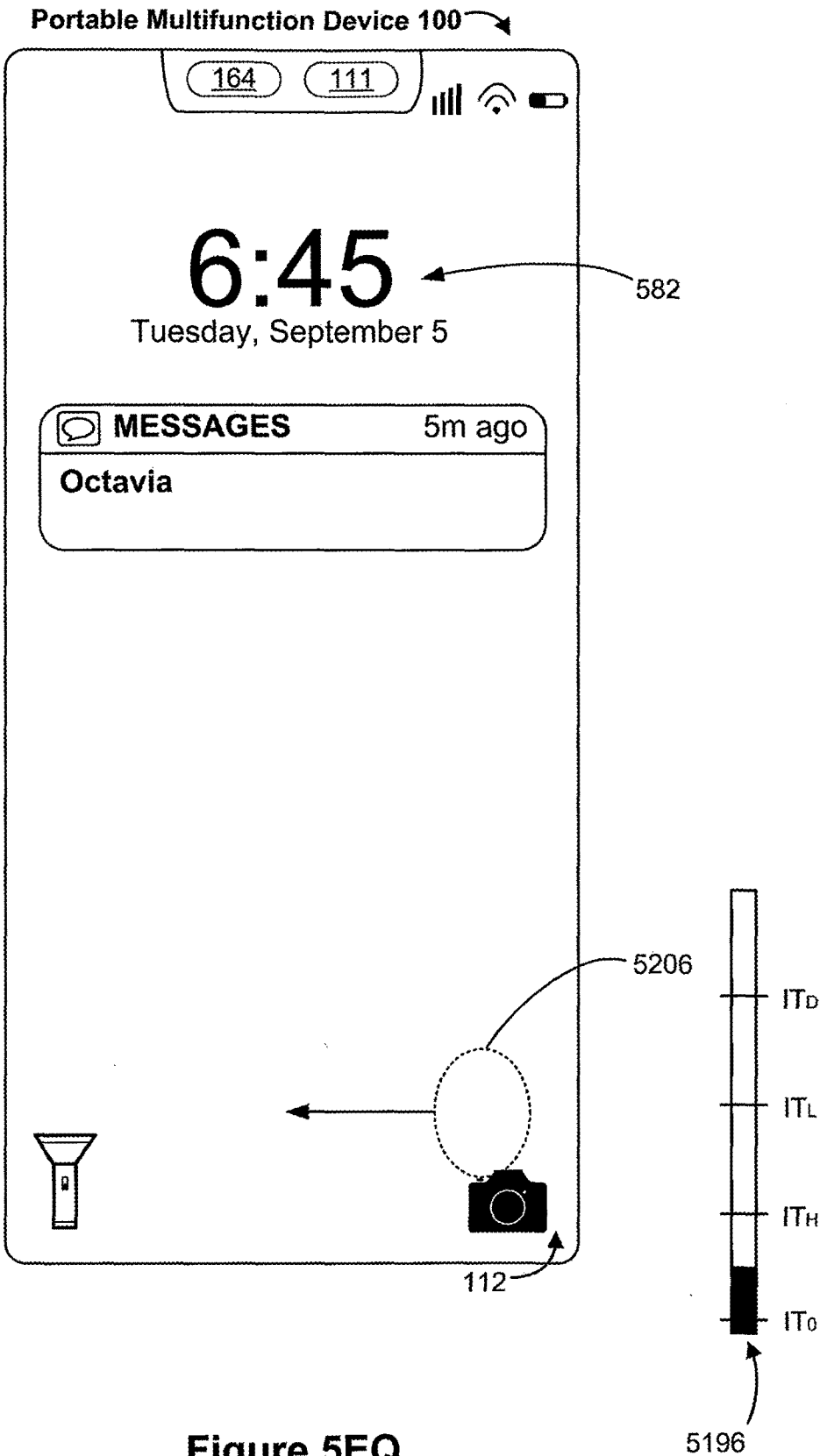


Figure 5EQ

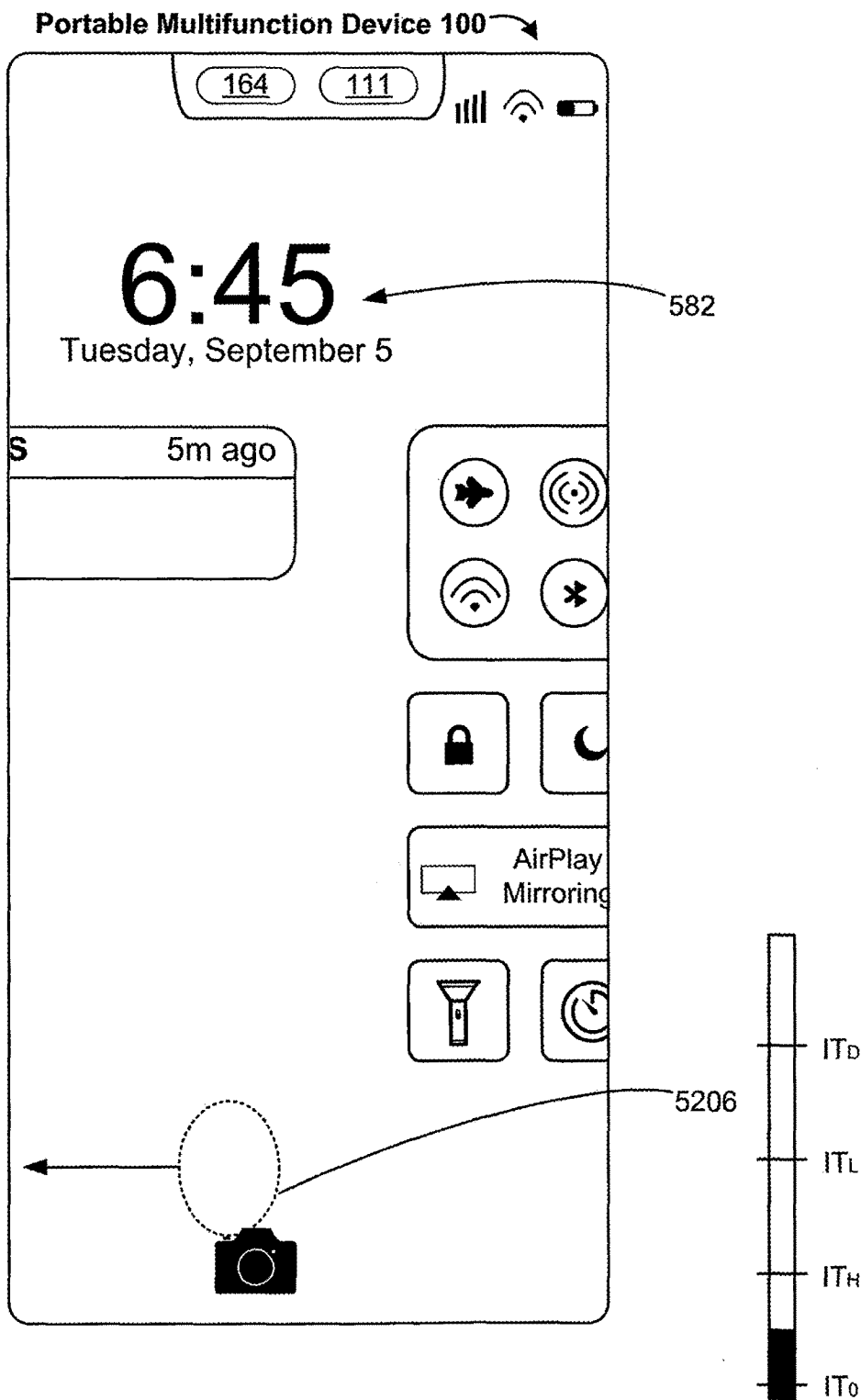
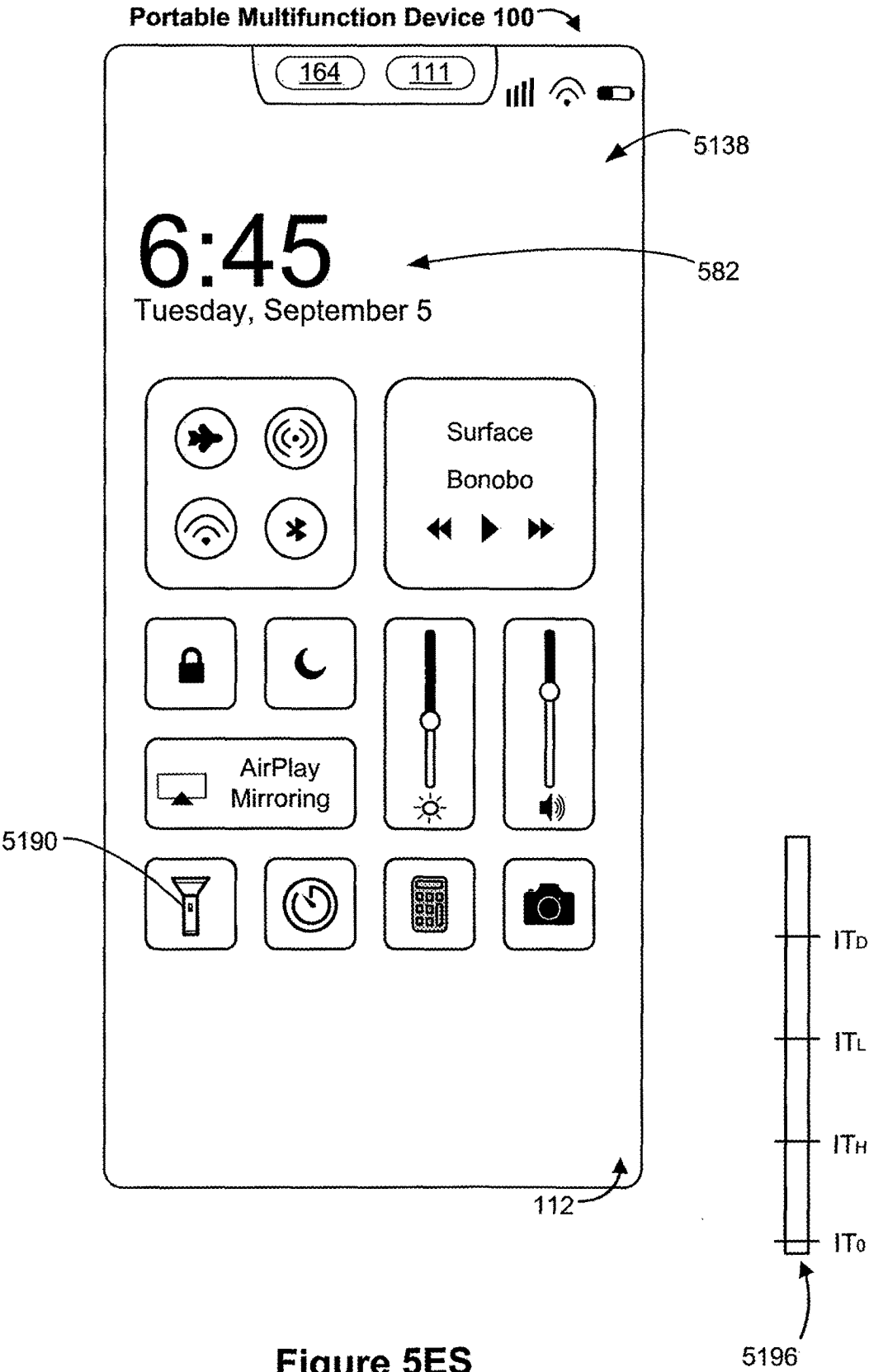


Figure 5ER



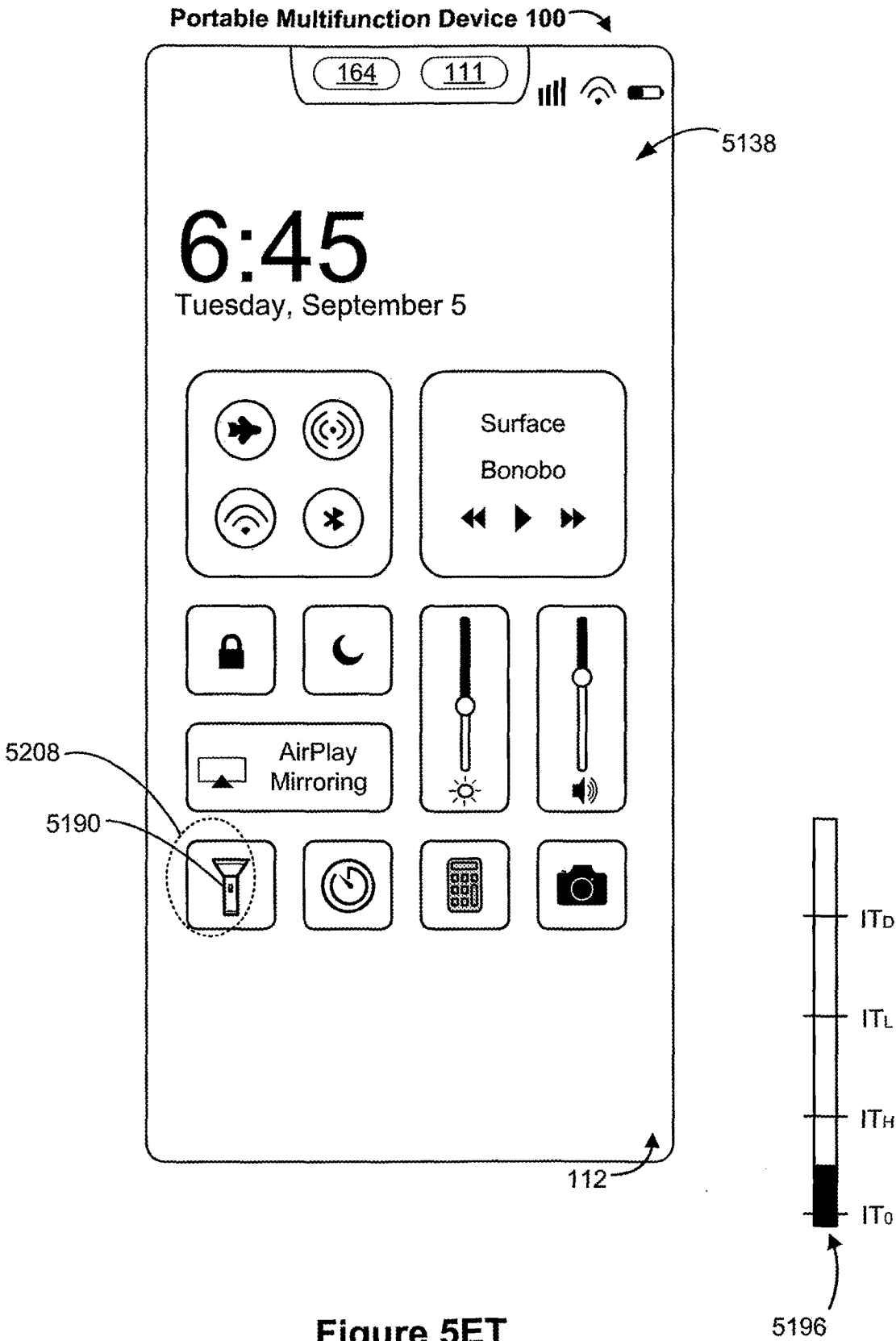
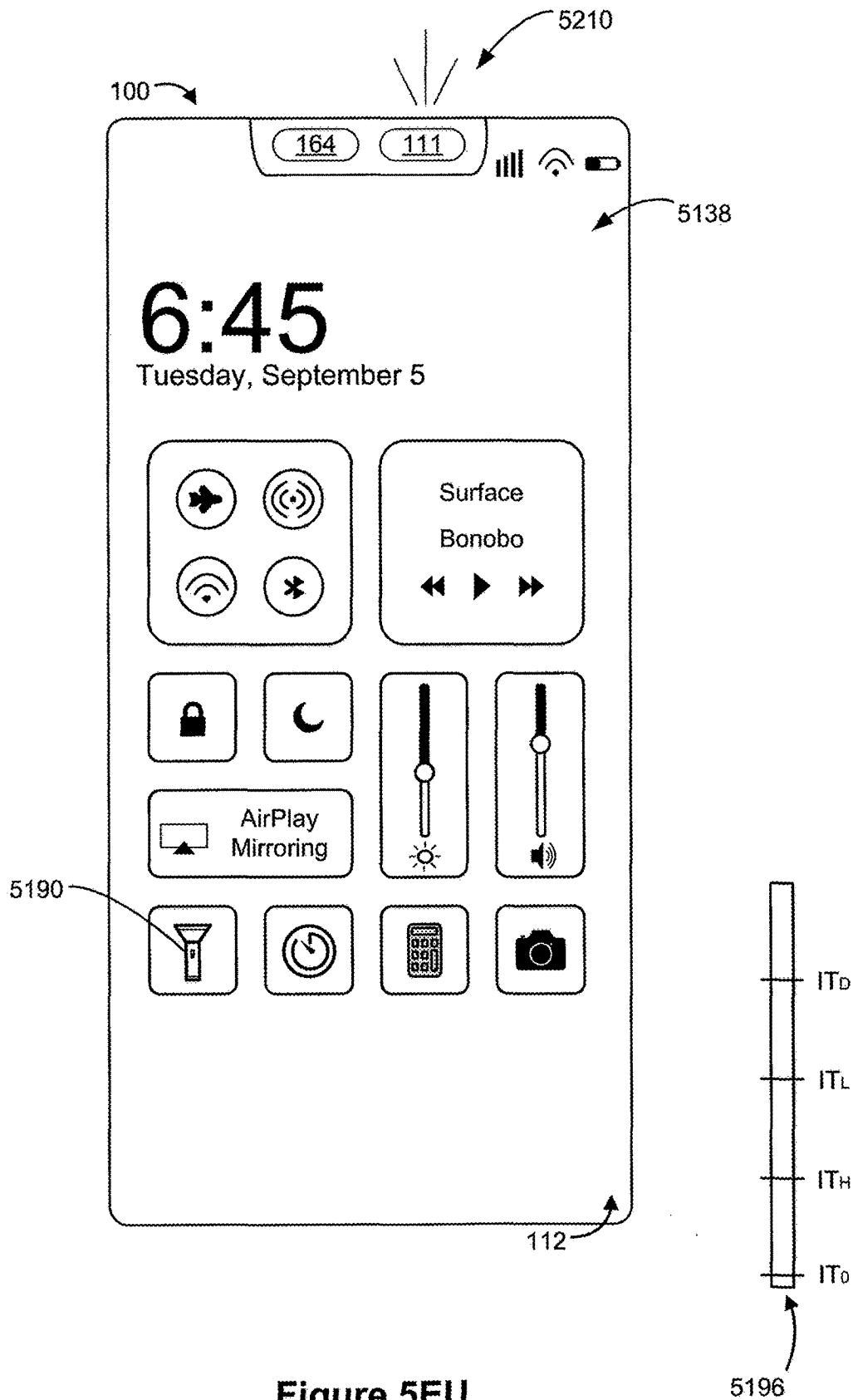


Figure 5ET





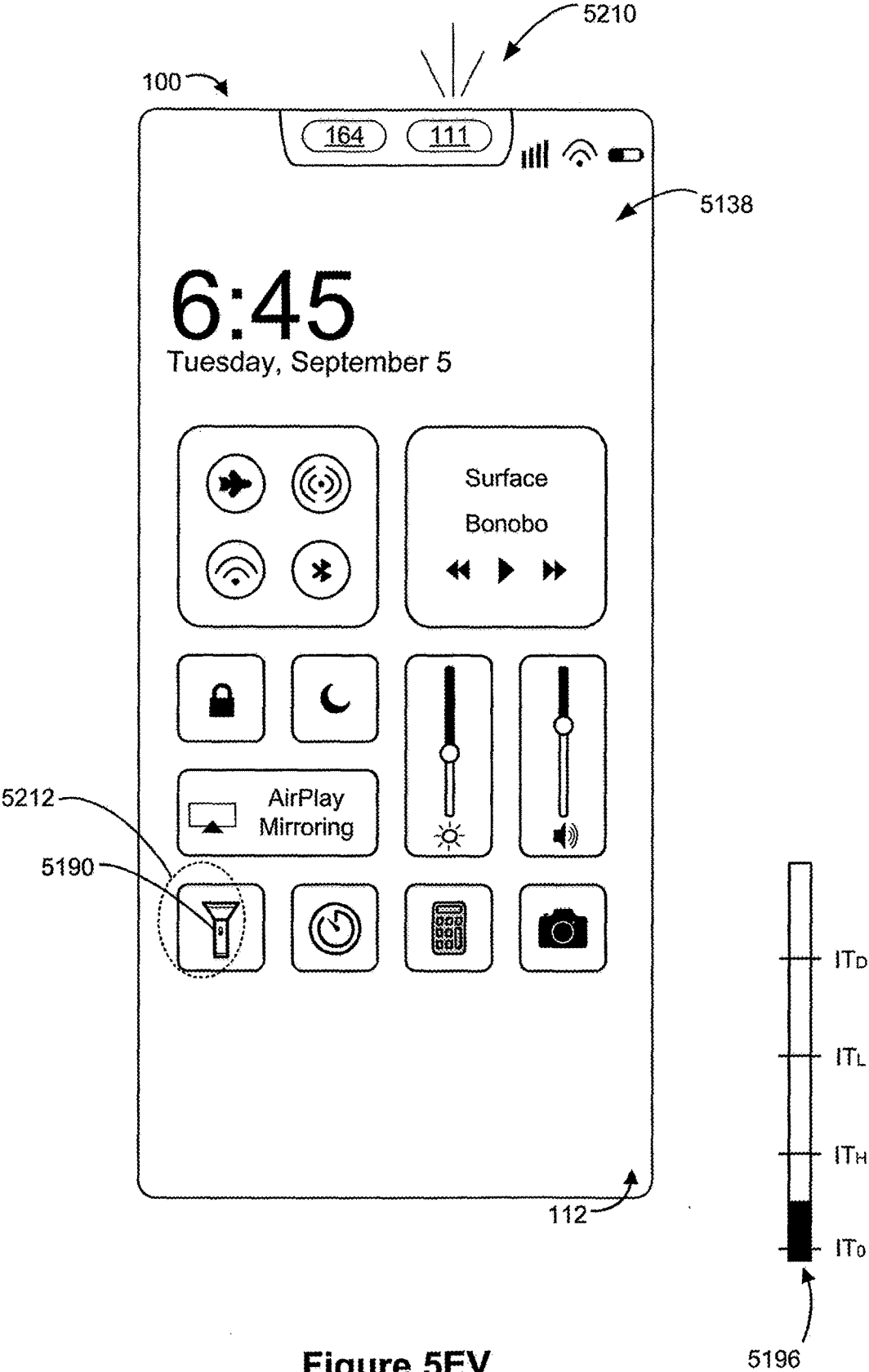


Figure 5EV

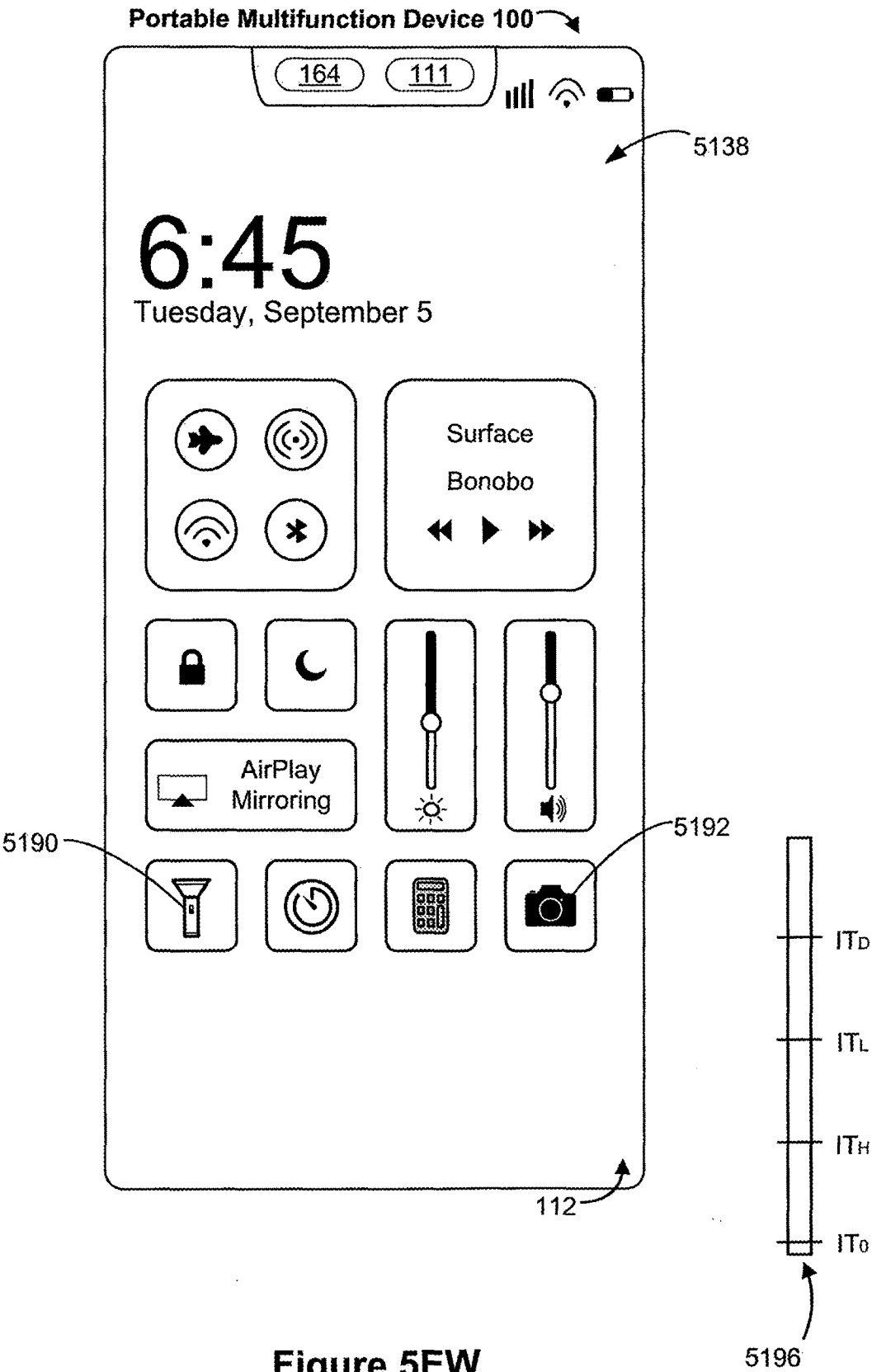
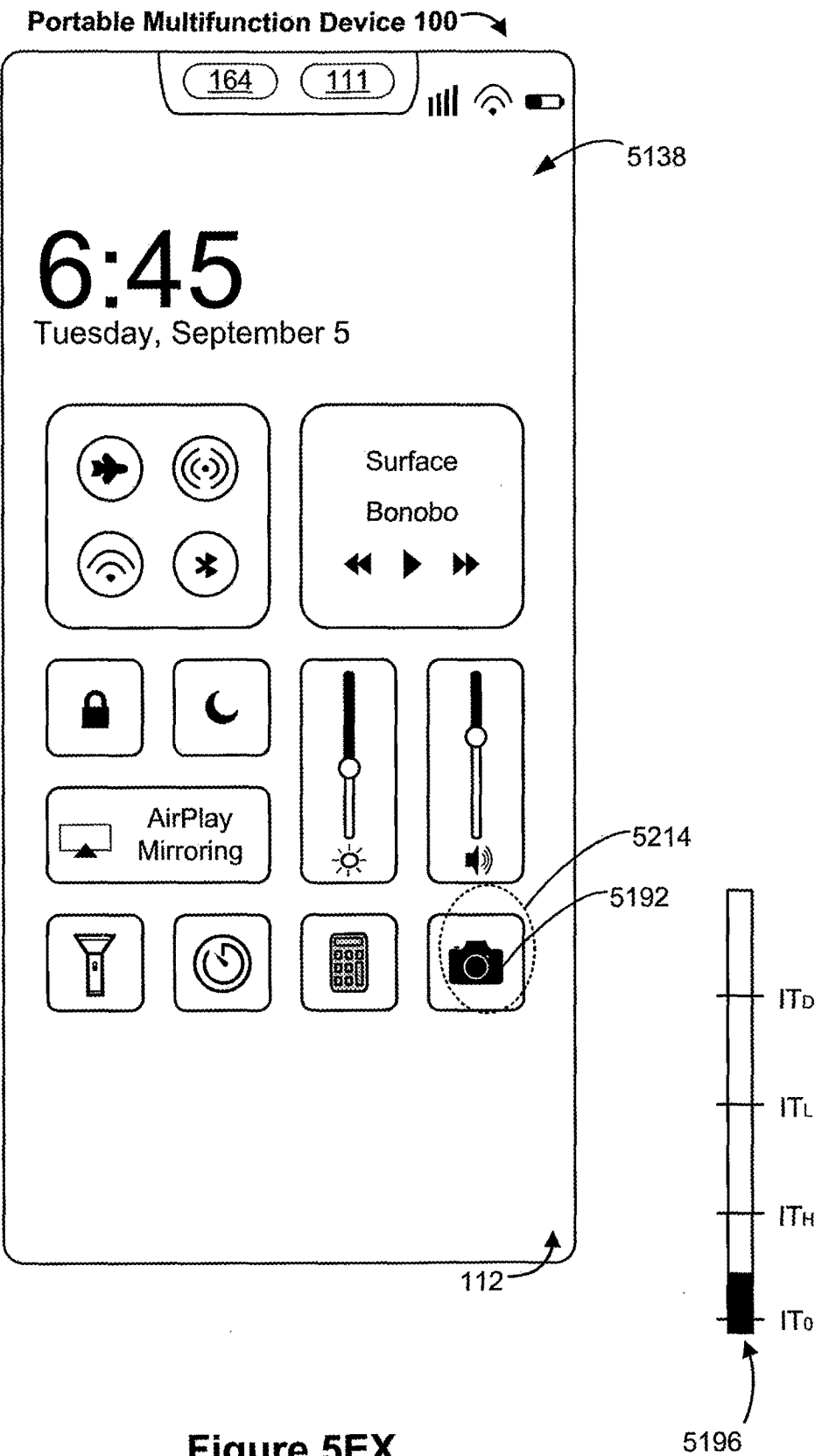


Figure 5EW



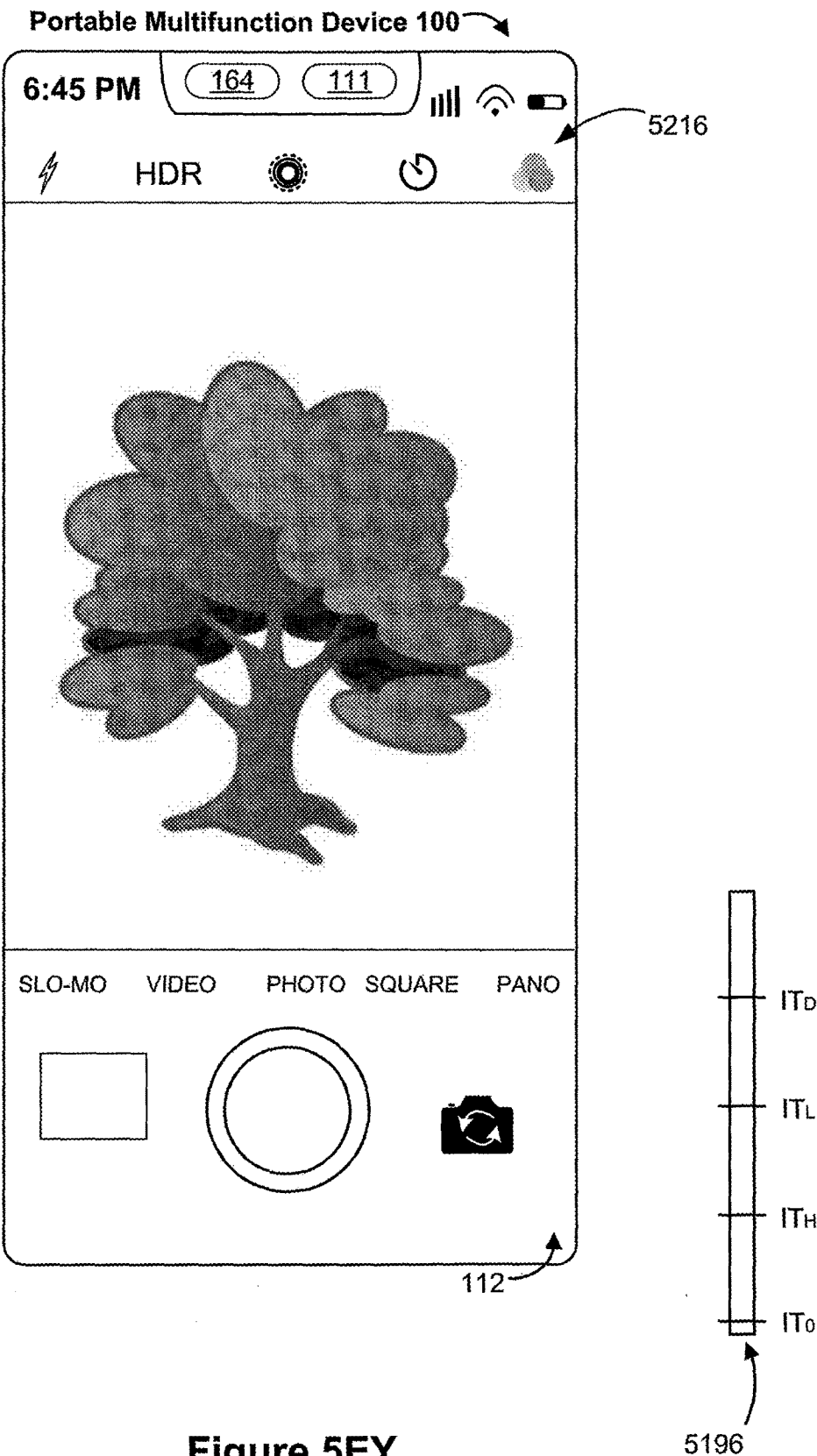


Figure 5EY

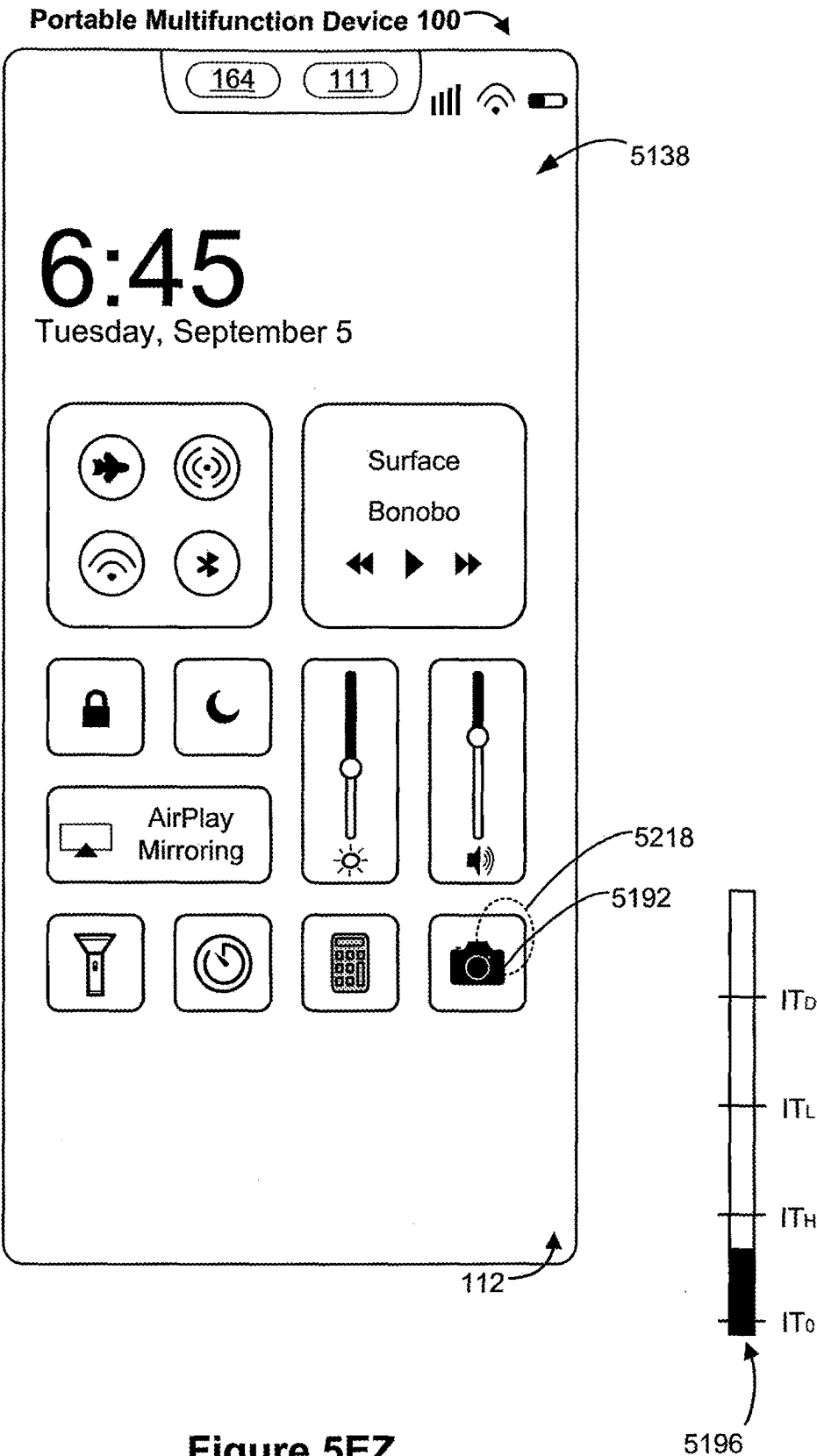


Figure 5EZ

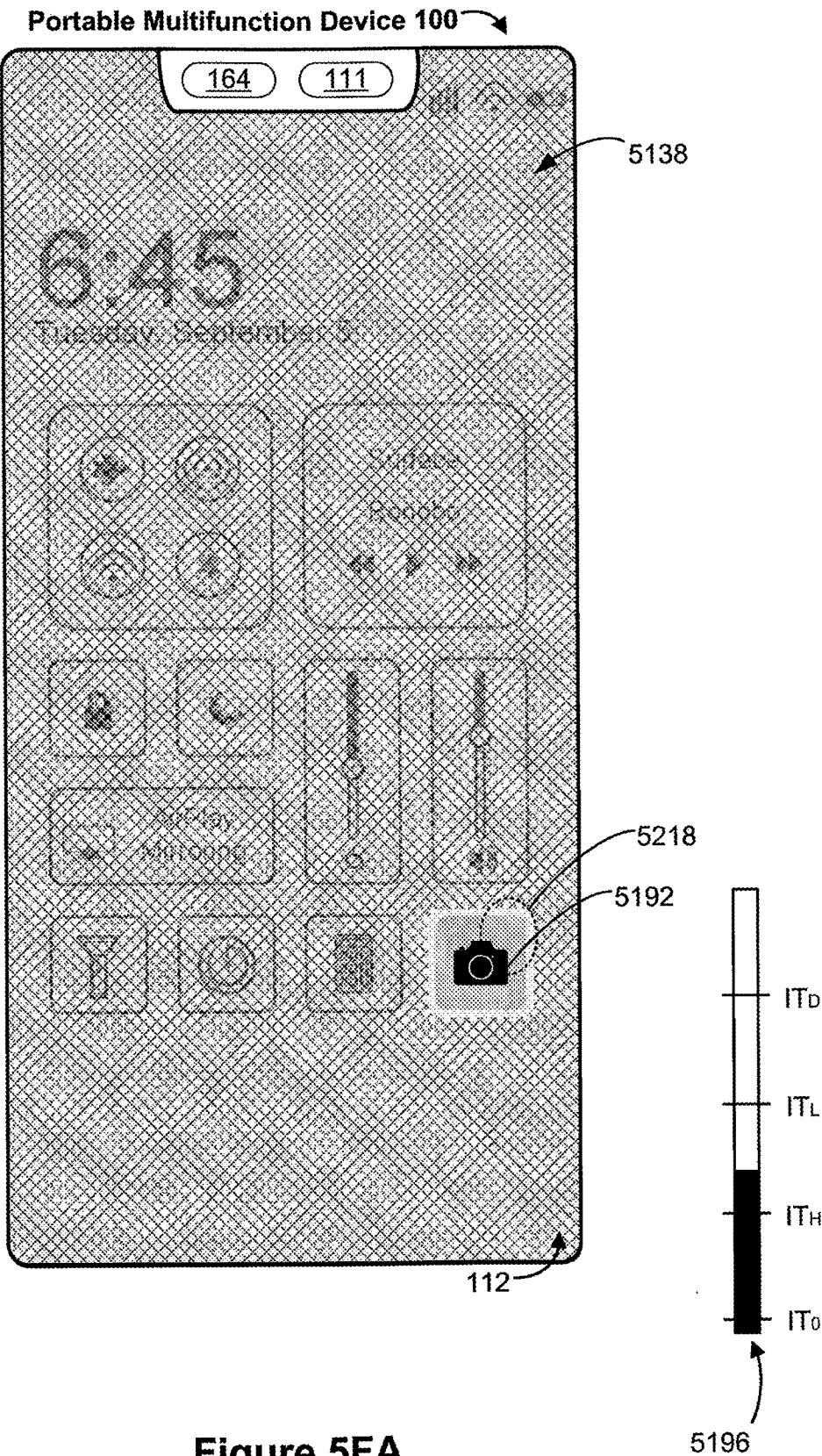


Figure 5FA



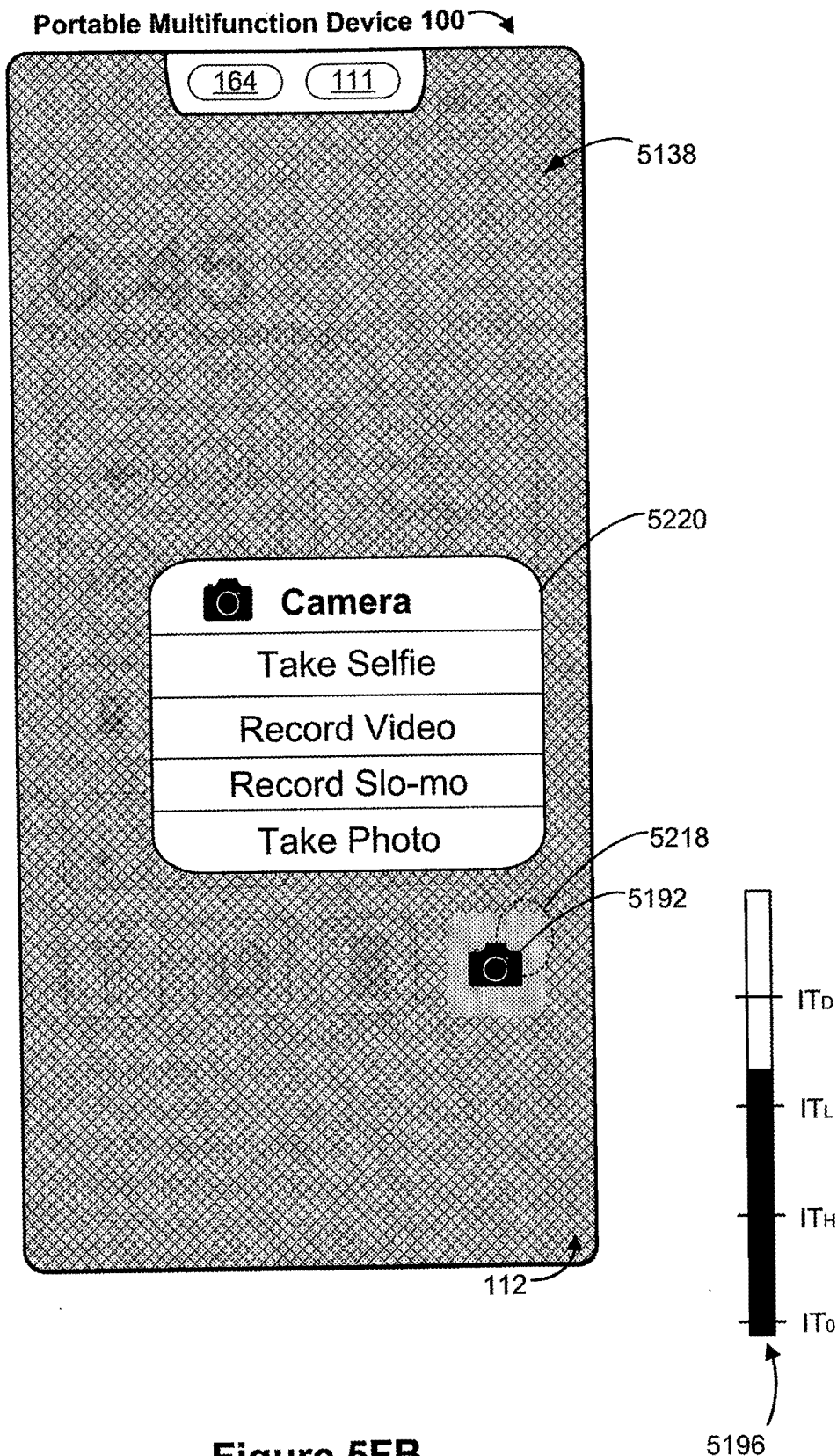


Figure 5FB

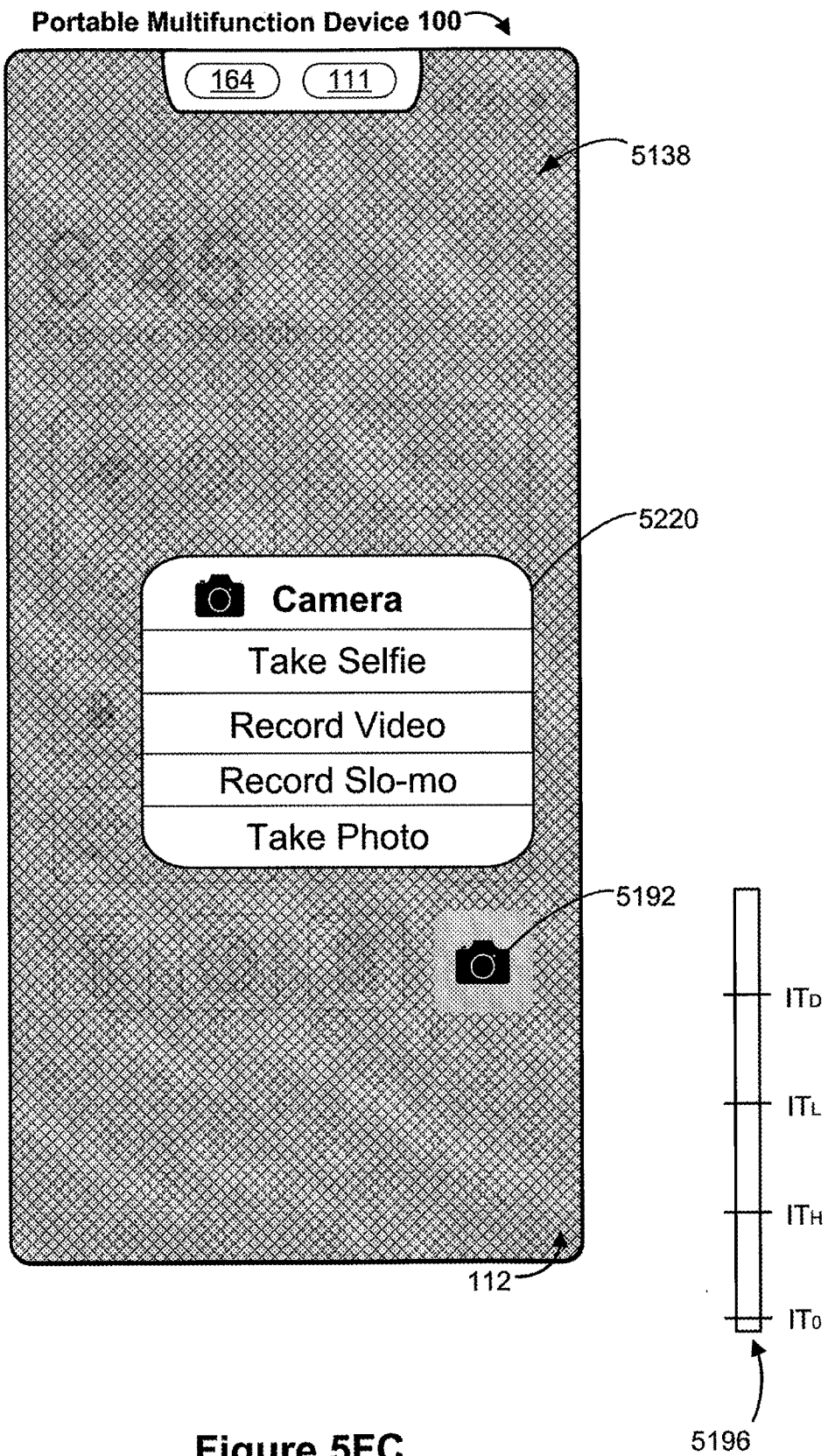


Figure 5FC



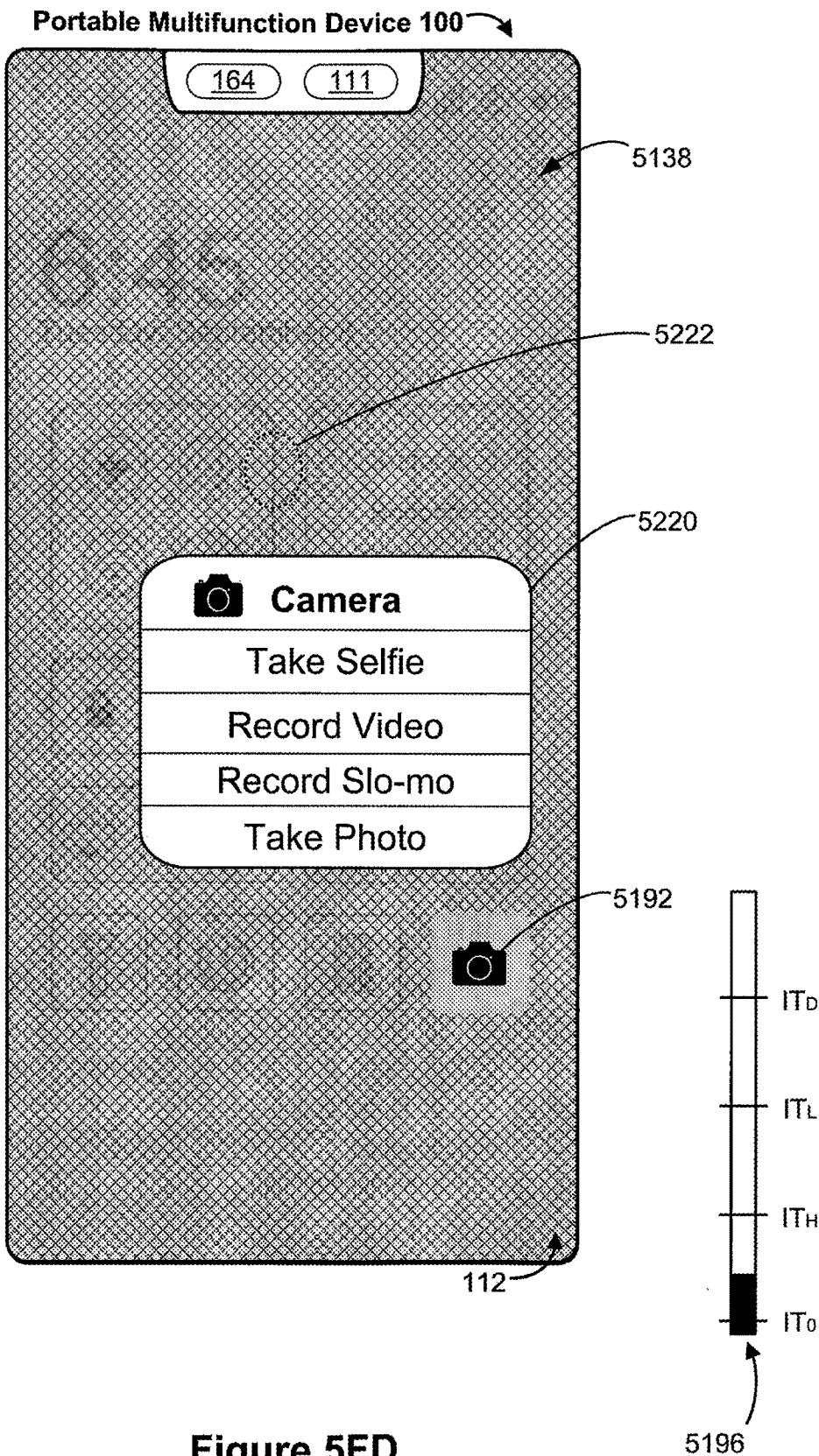


Figure 5FD

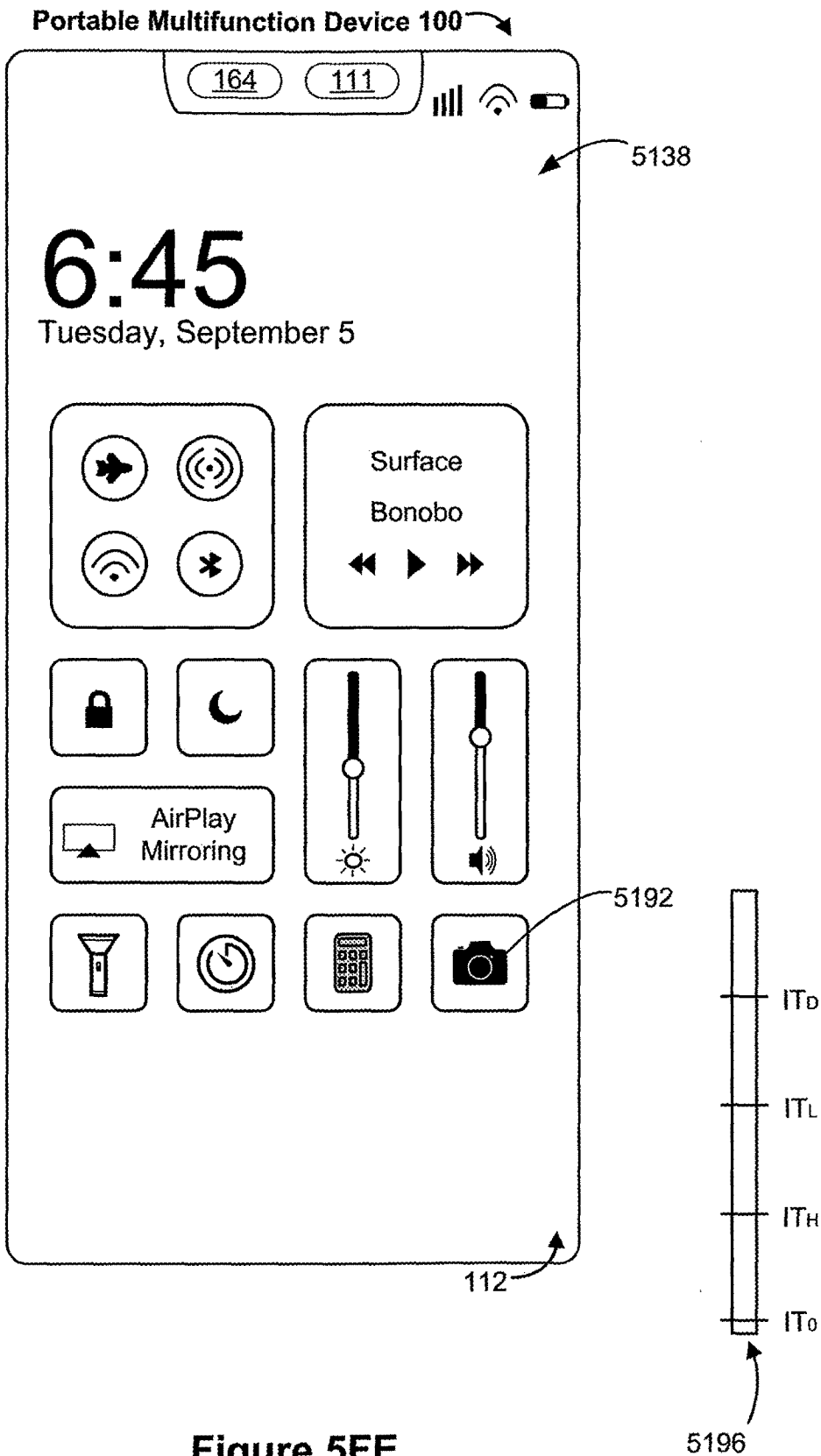
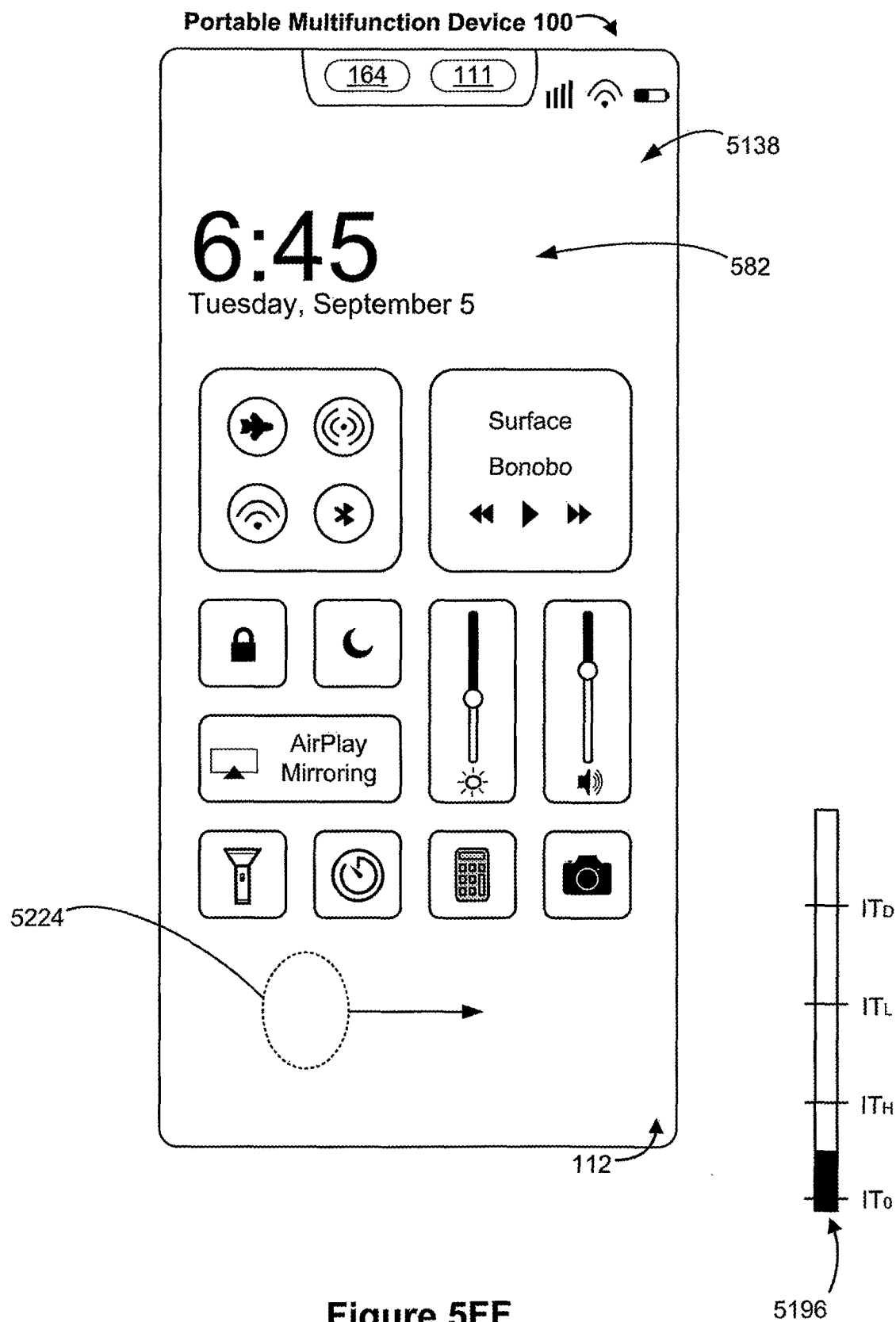


Figure 5FE



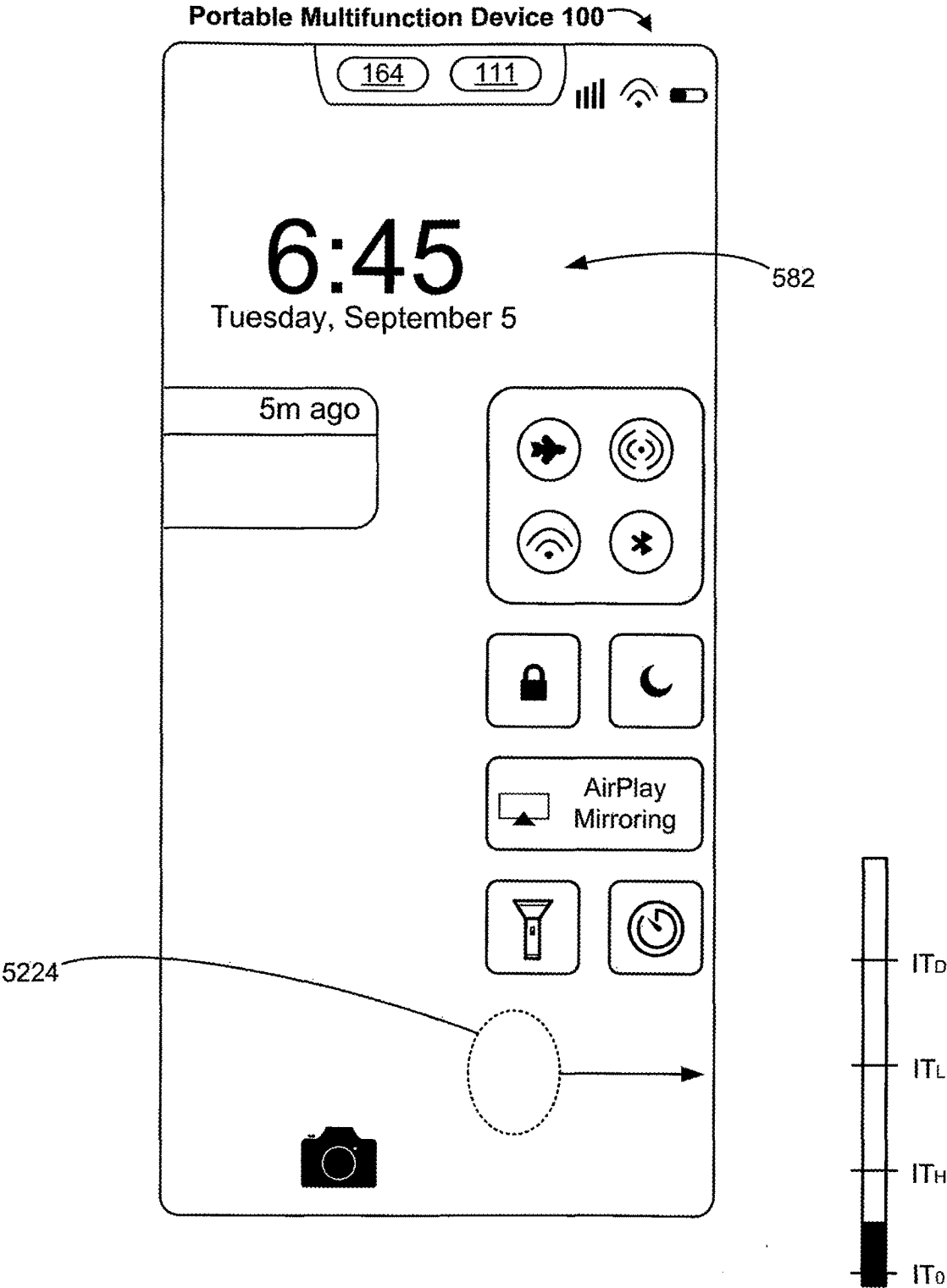


Figure 5FG

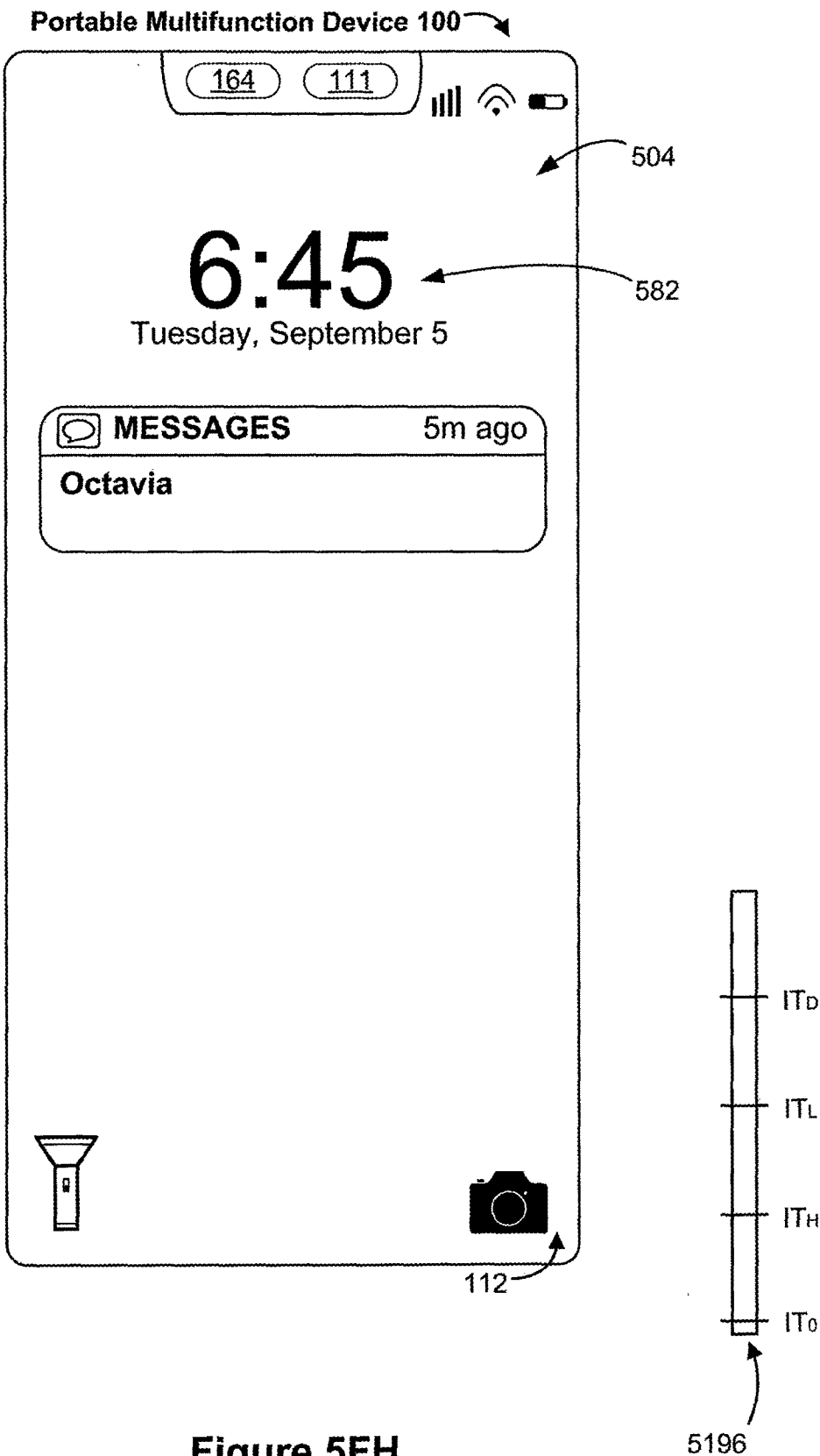


Figure 5FH

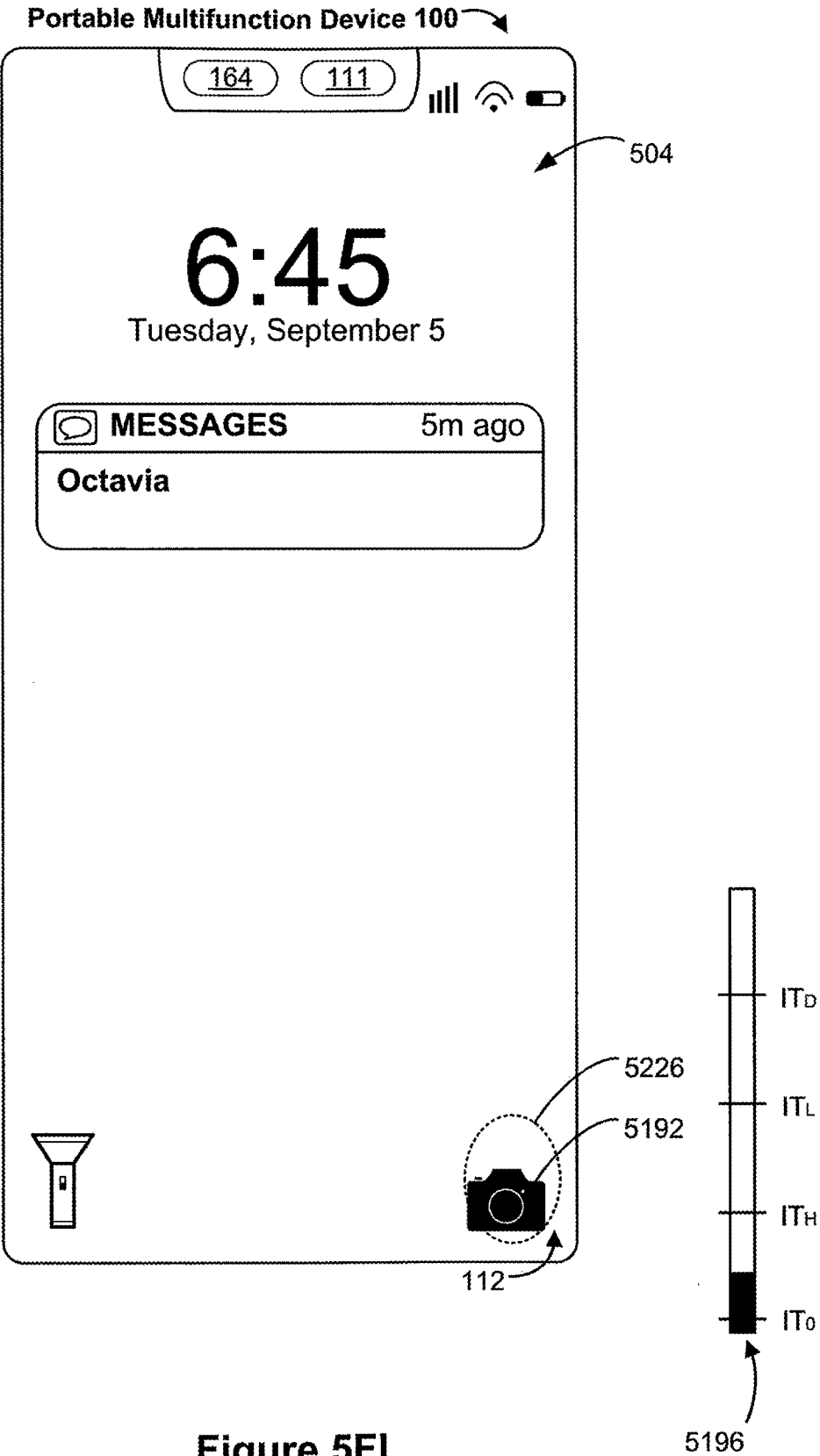


Figure 5FI

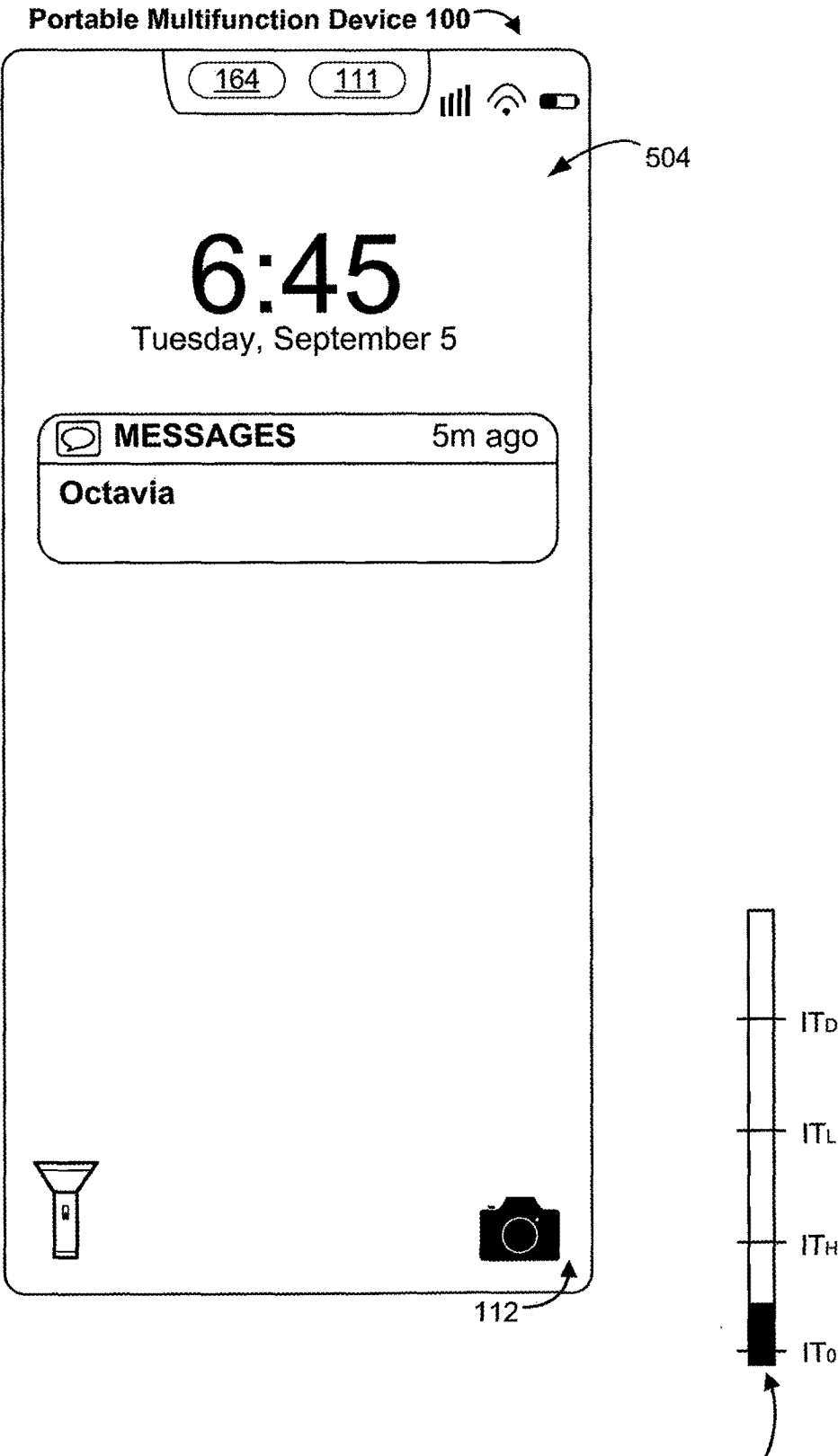
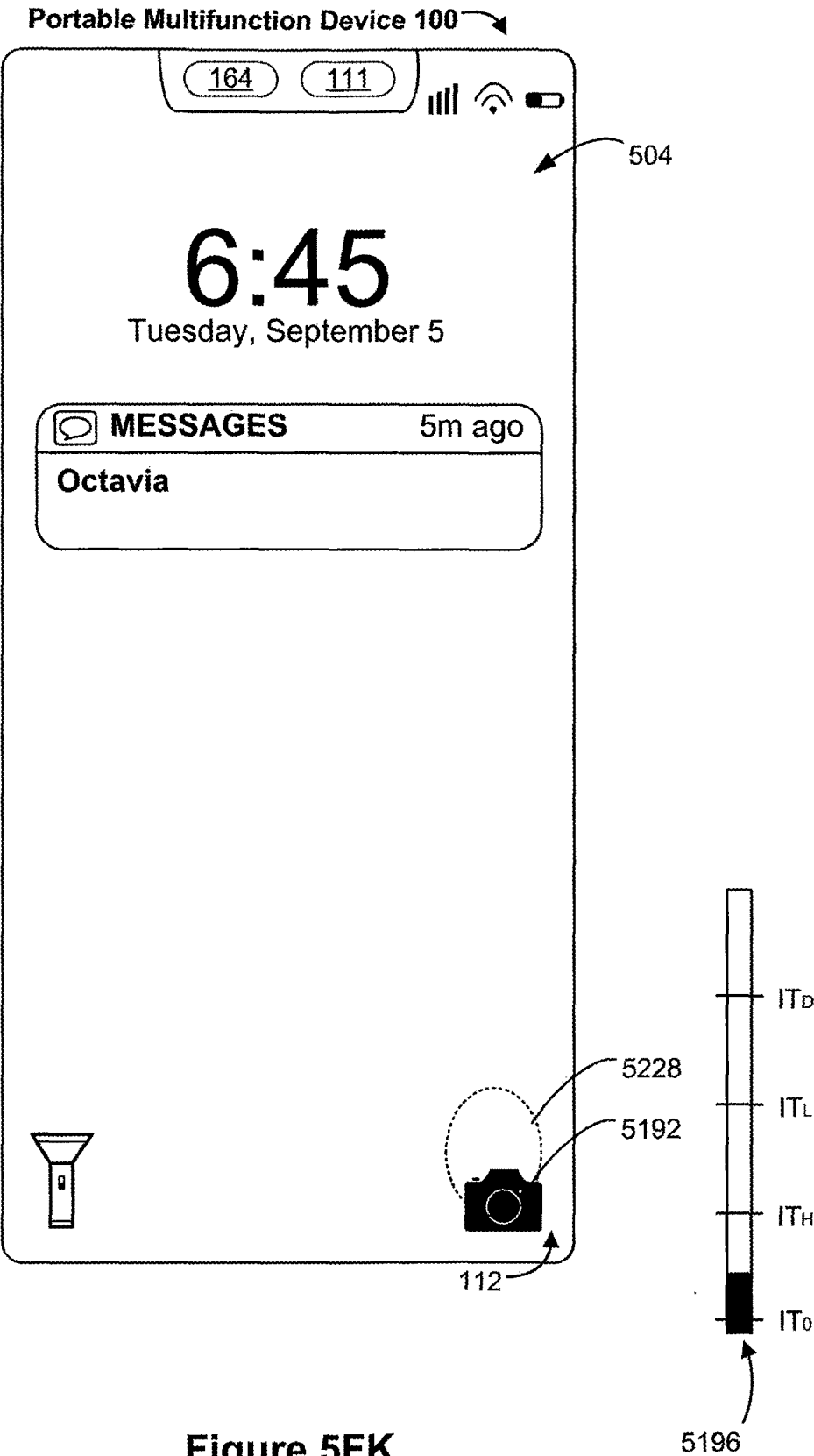


Figure 5FJ





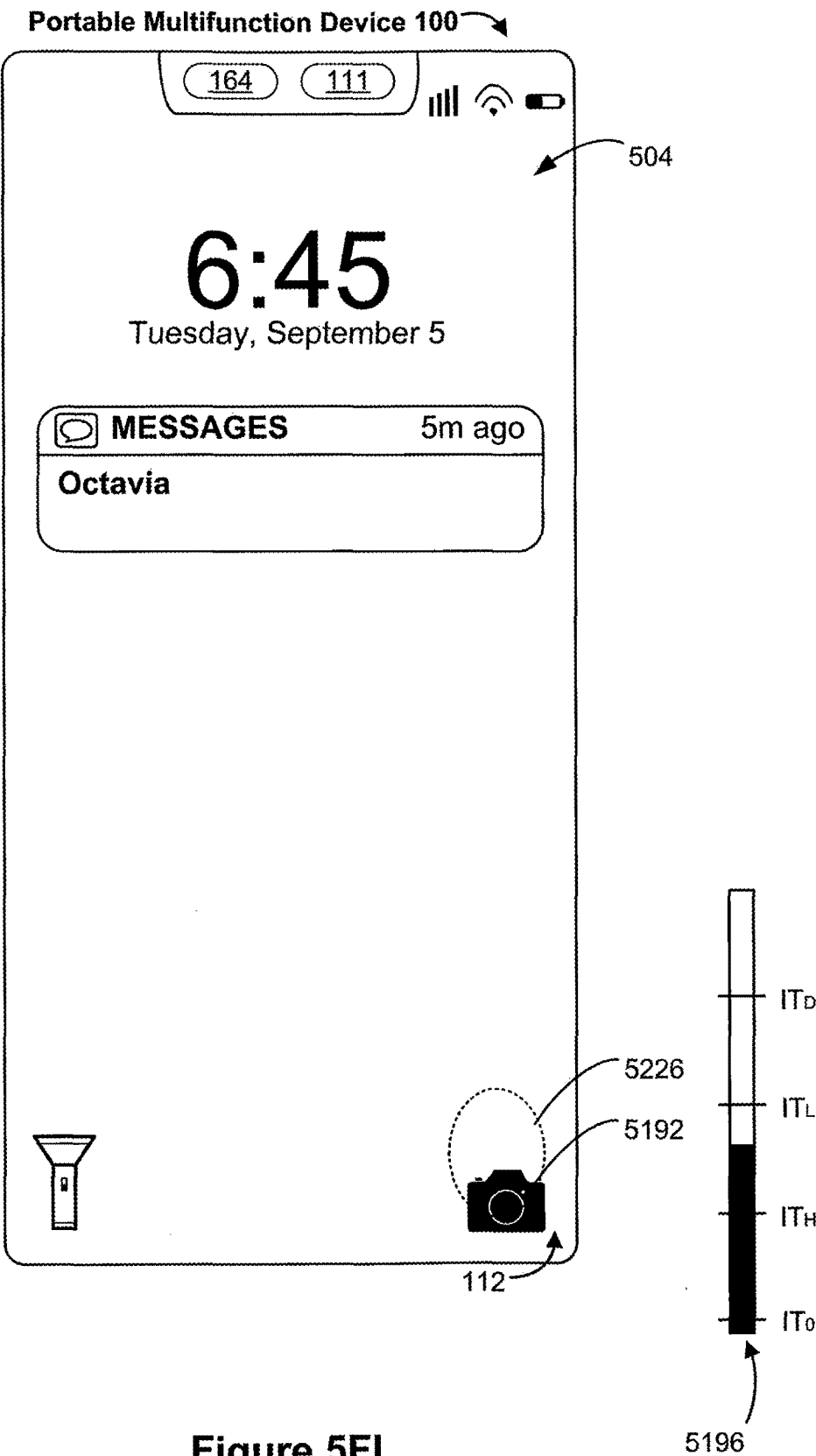


Figure 5FL

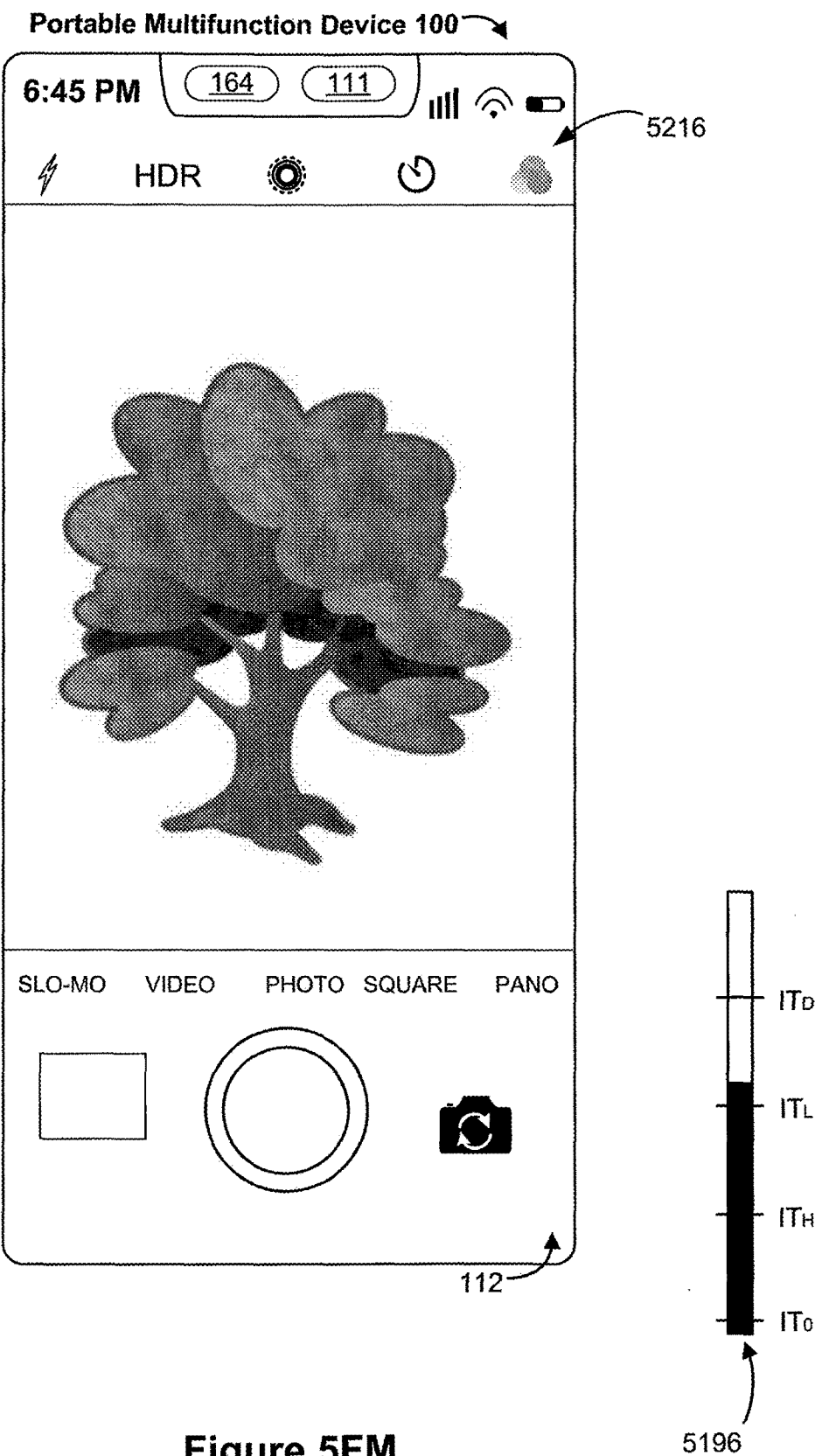
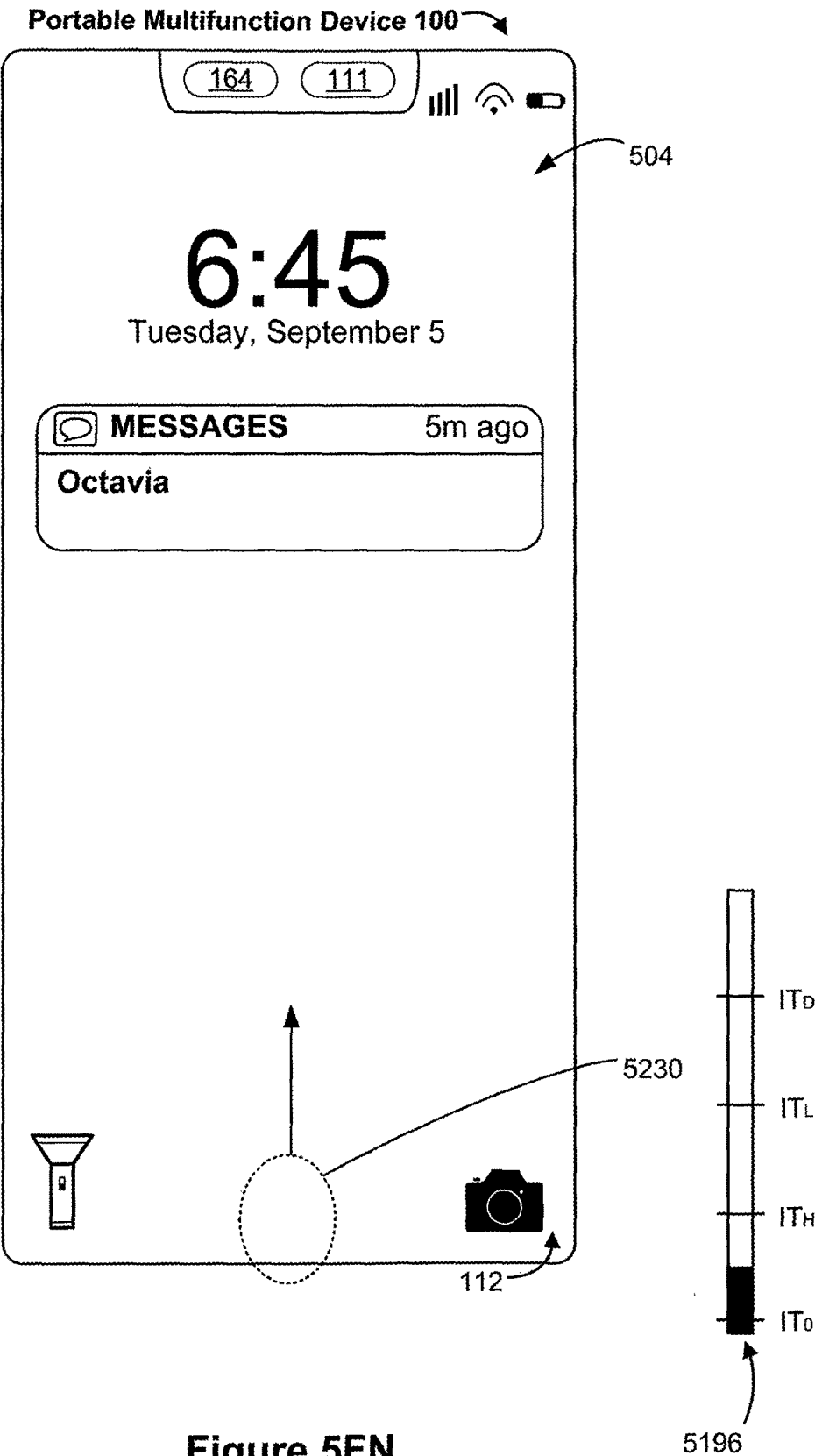


Figure 5FM



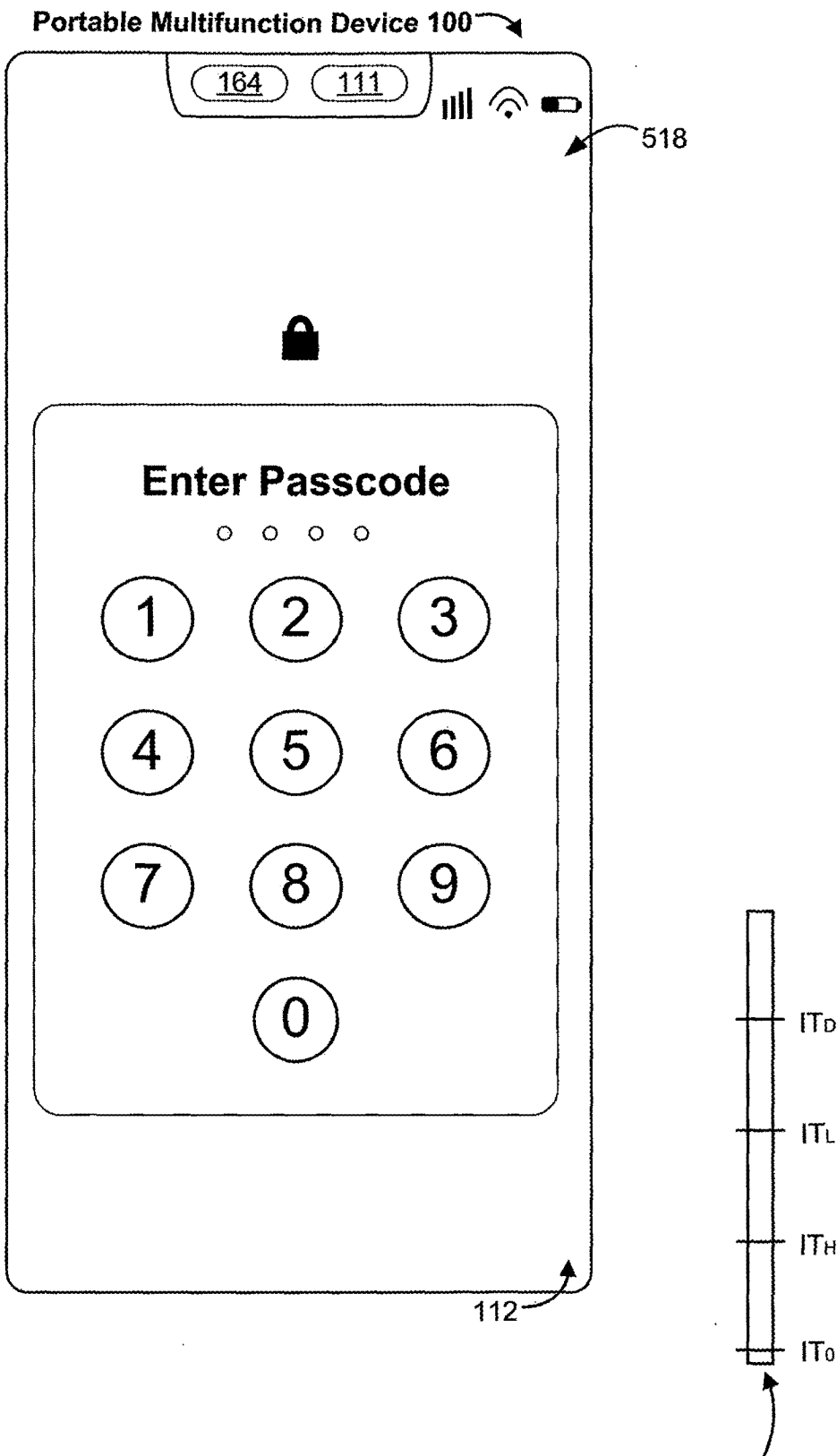


Figure 5FO

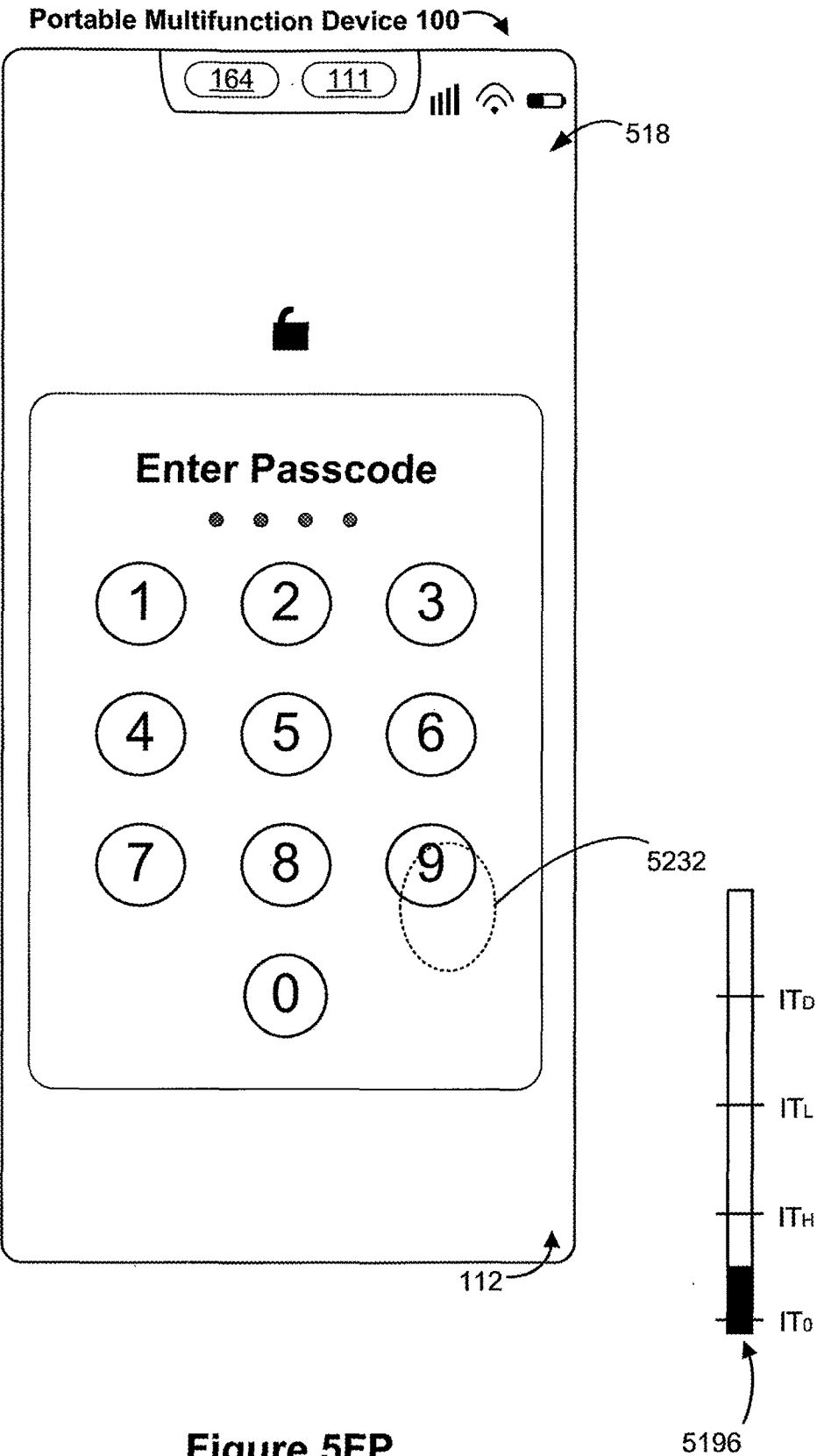
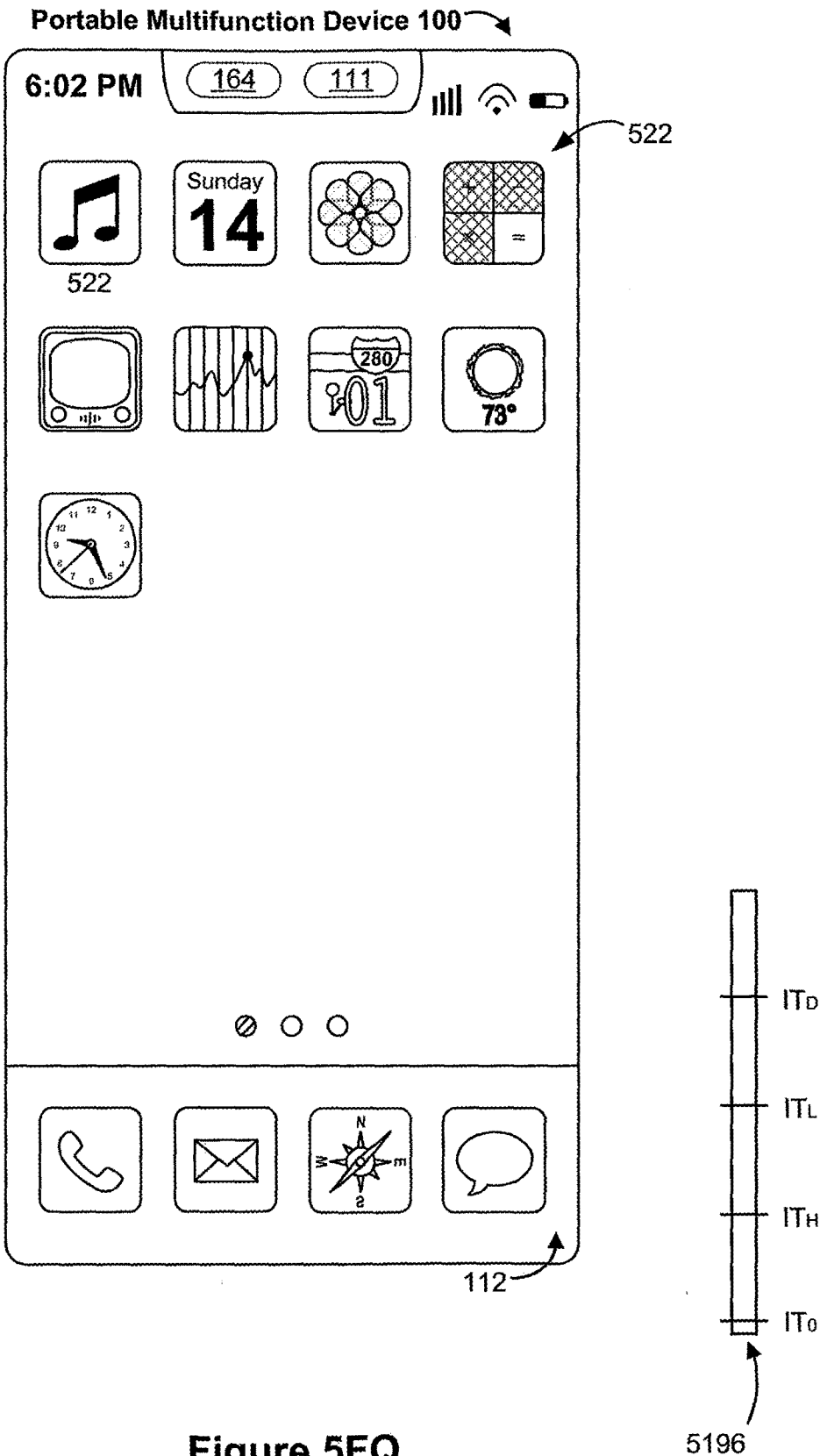
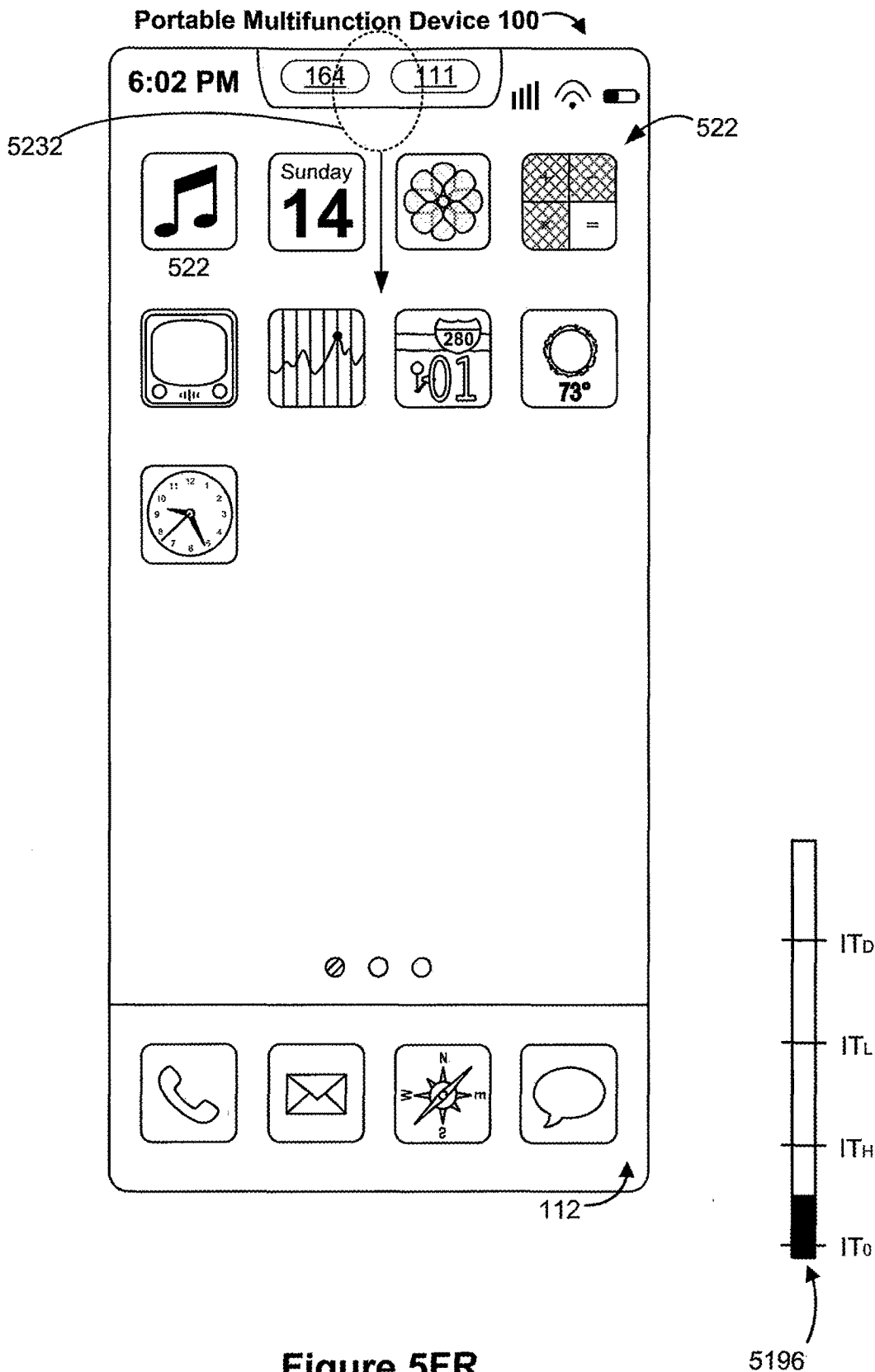
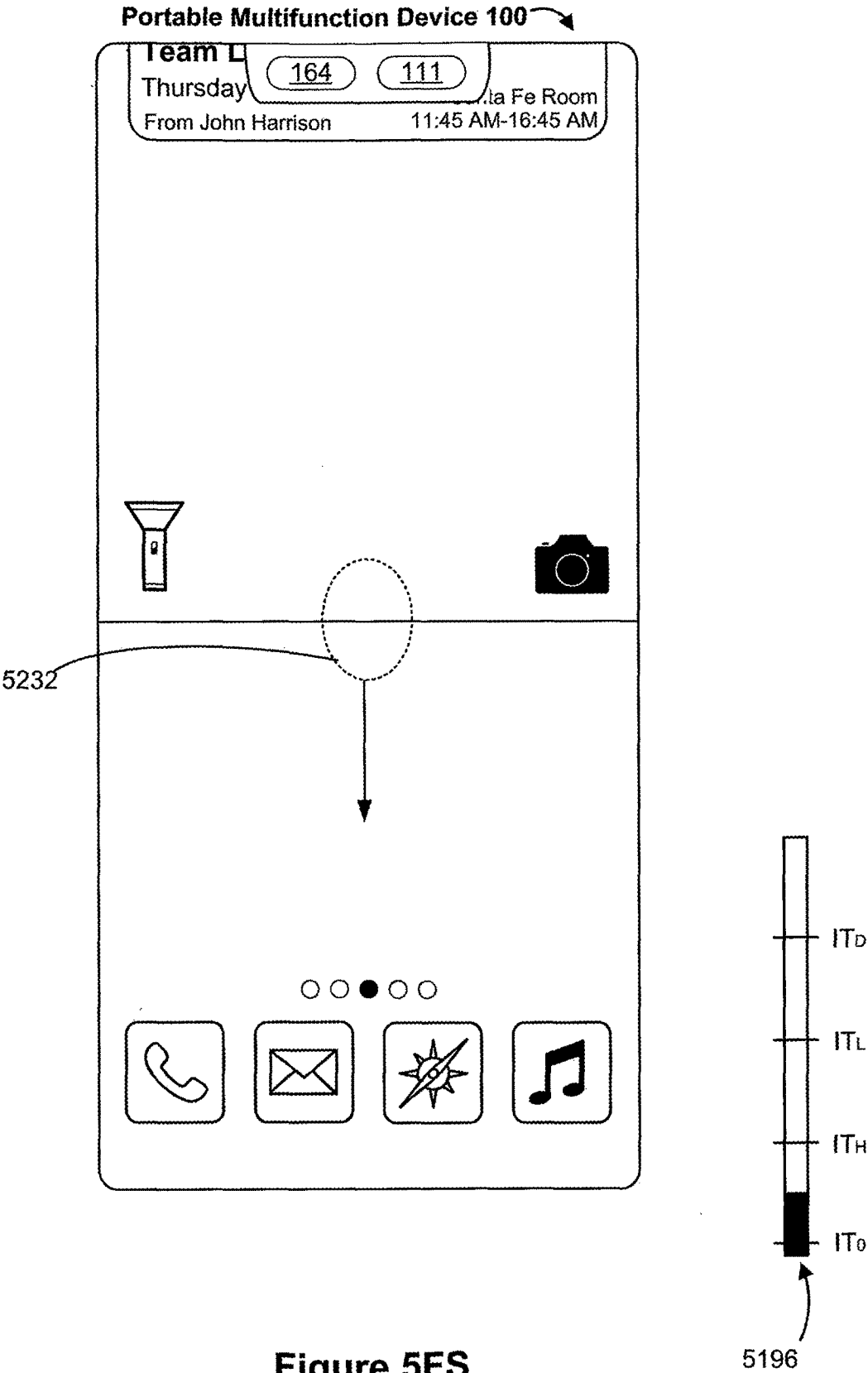


Figure 5FP









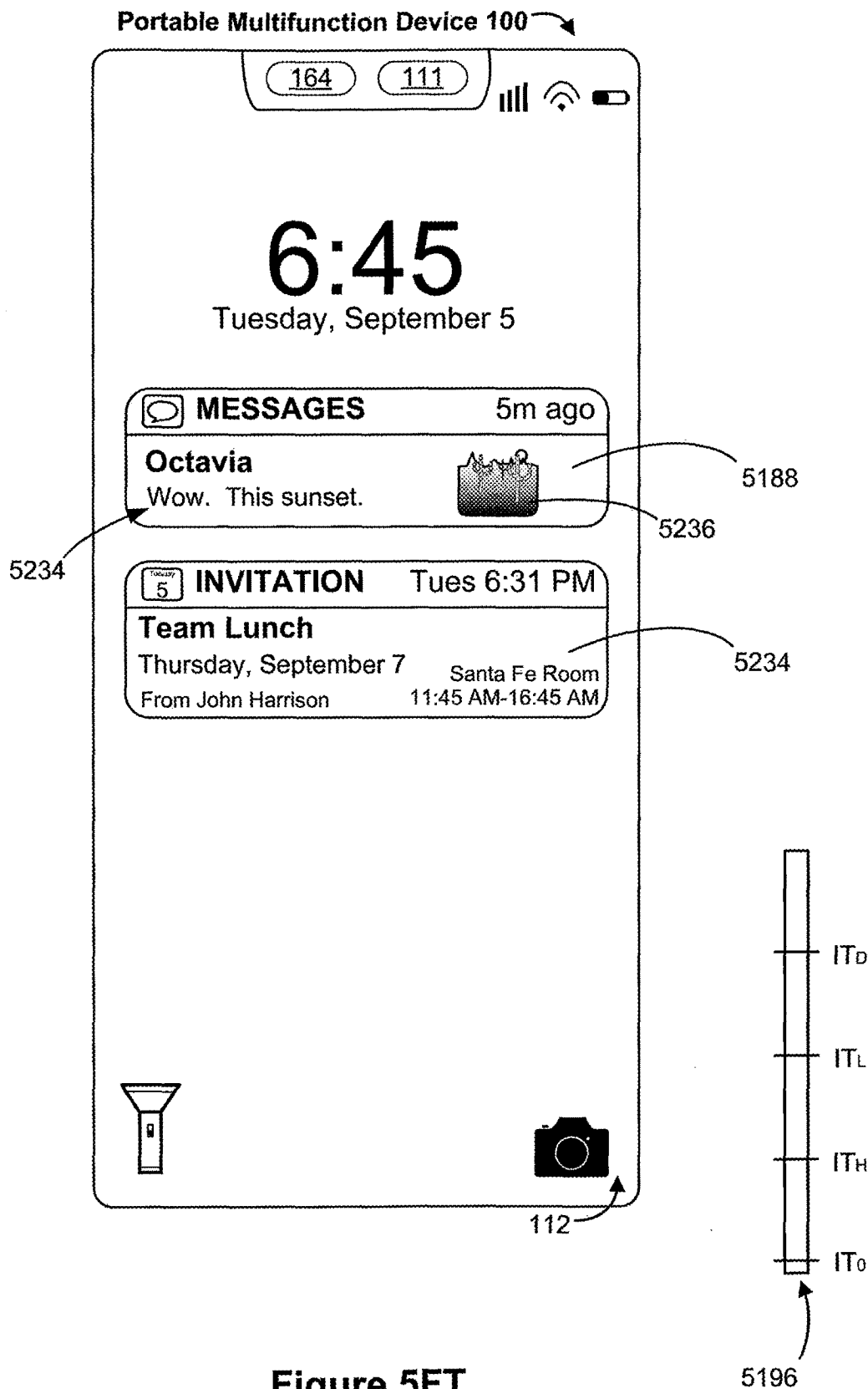


Figure 5FT

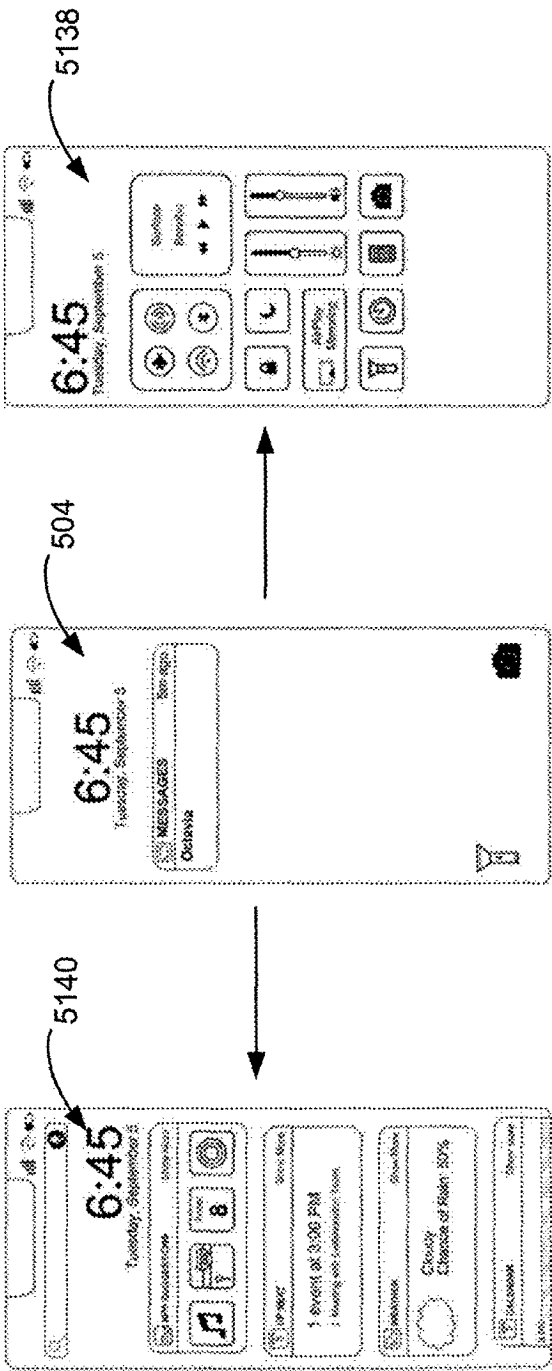
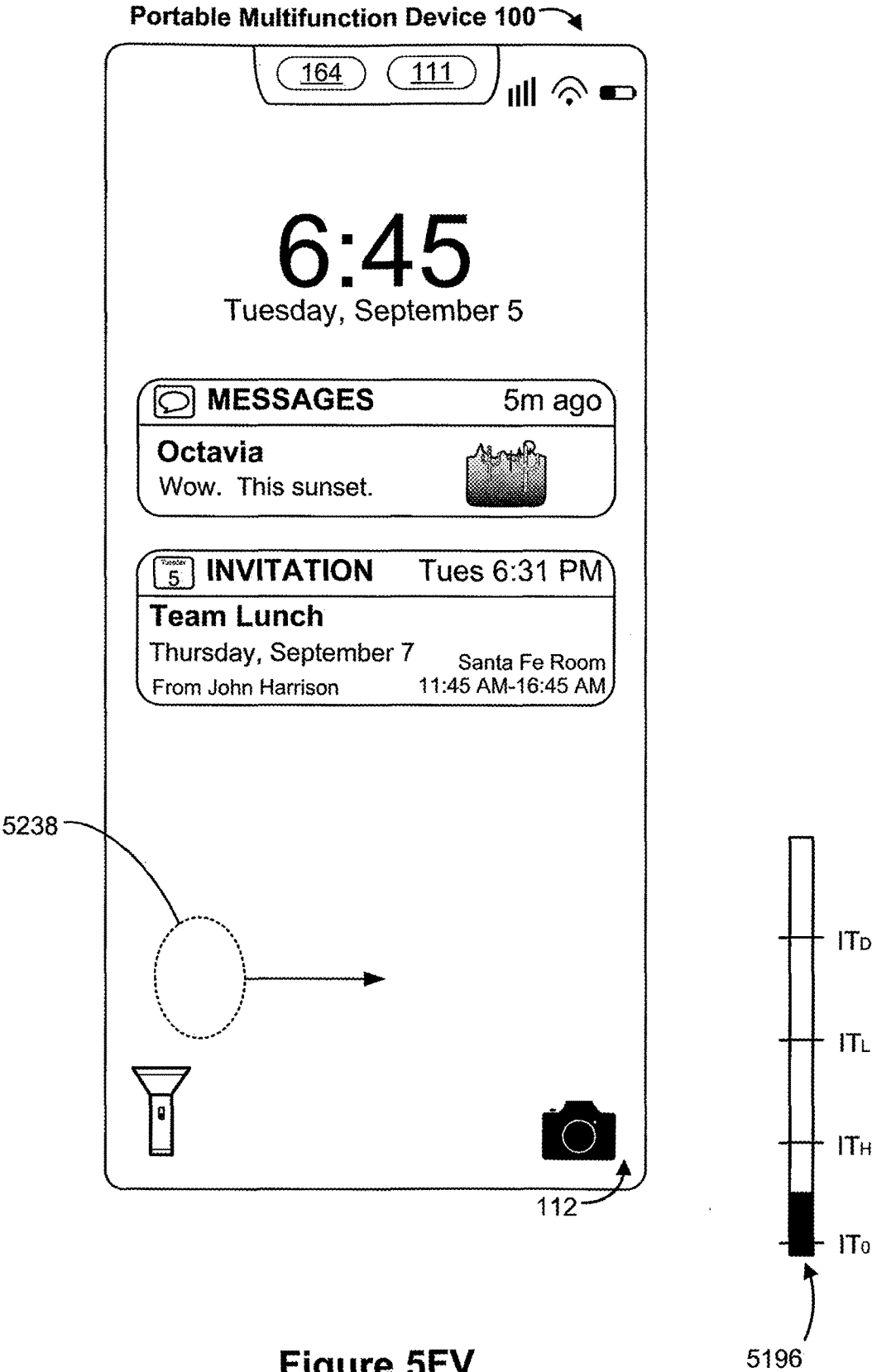
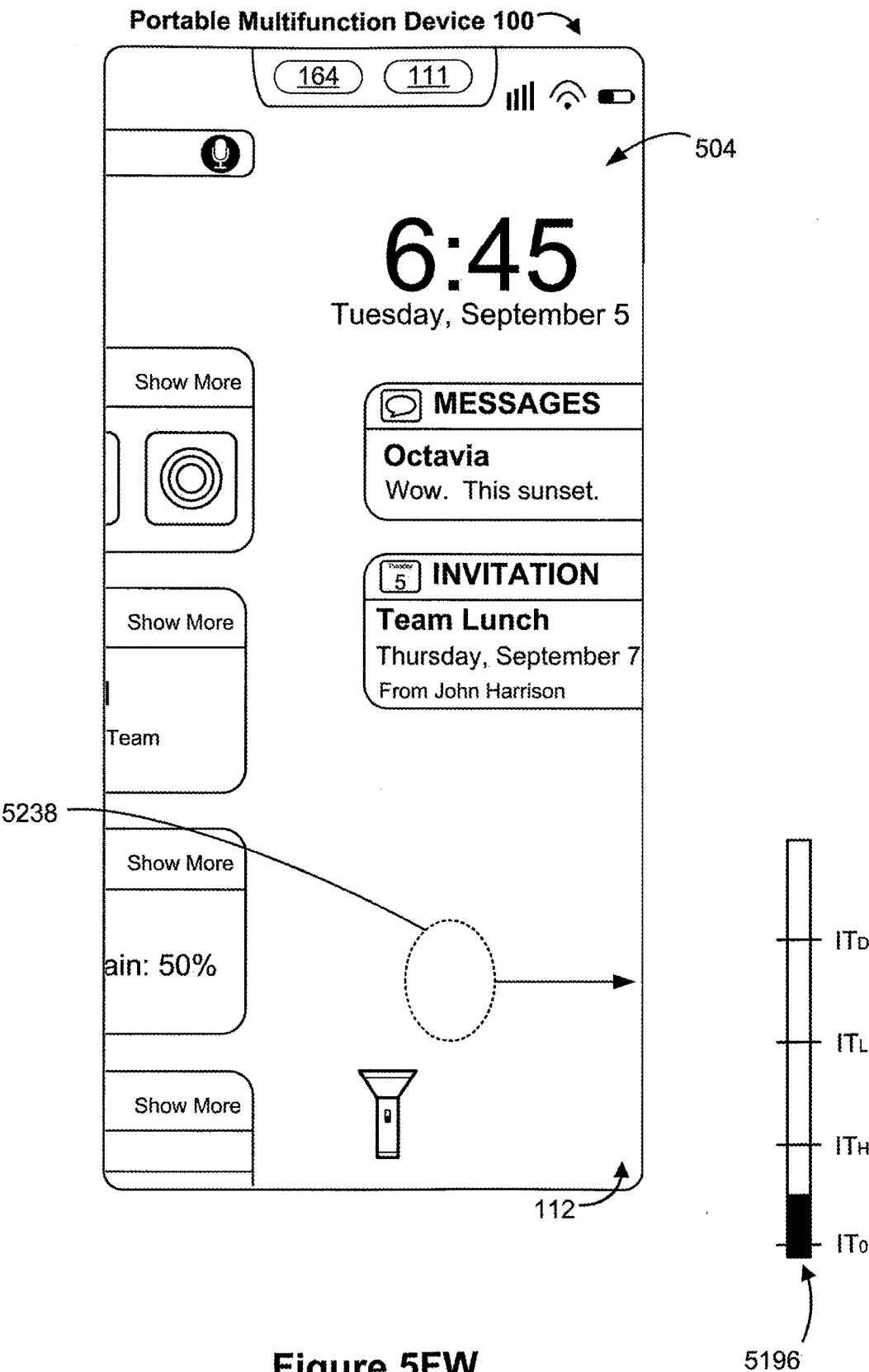


Figure 5FU





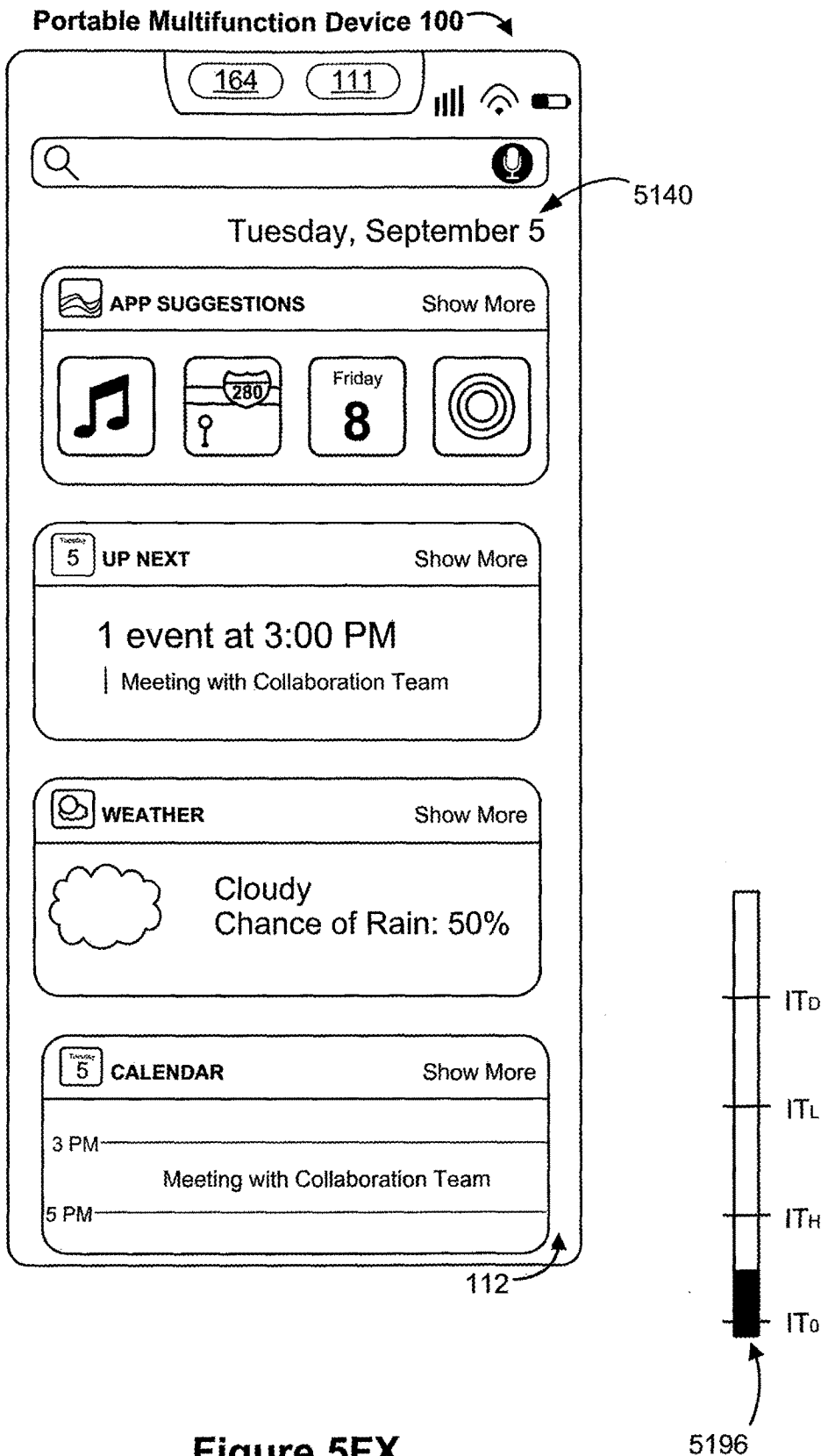
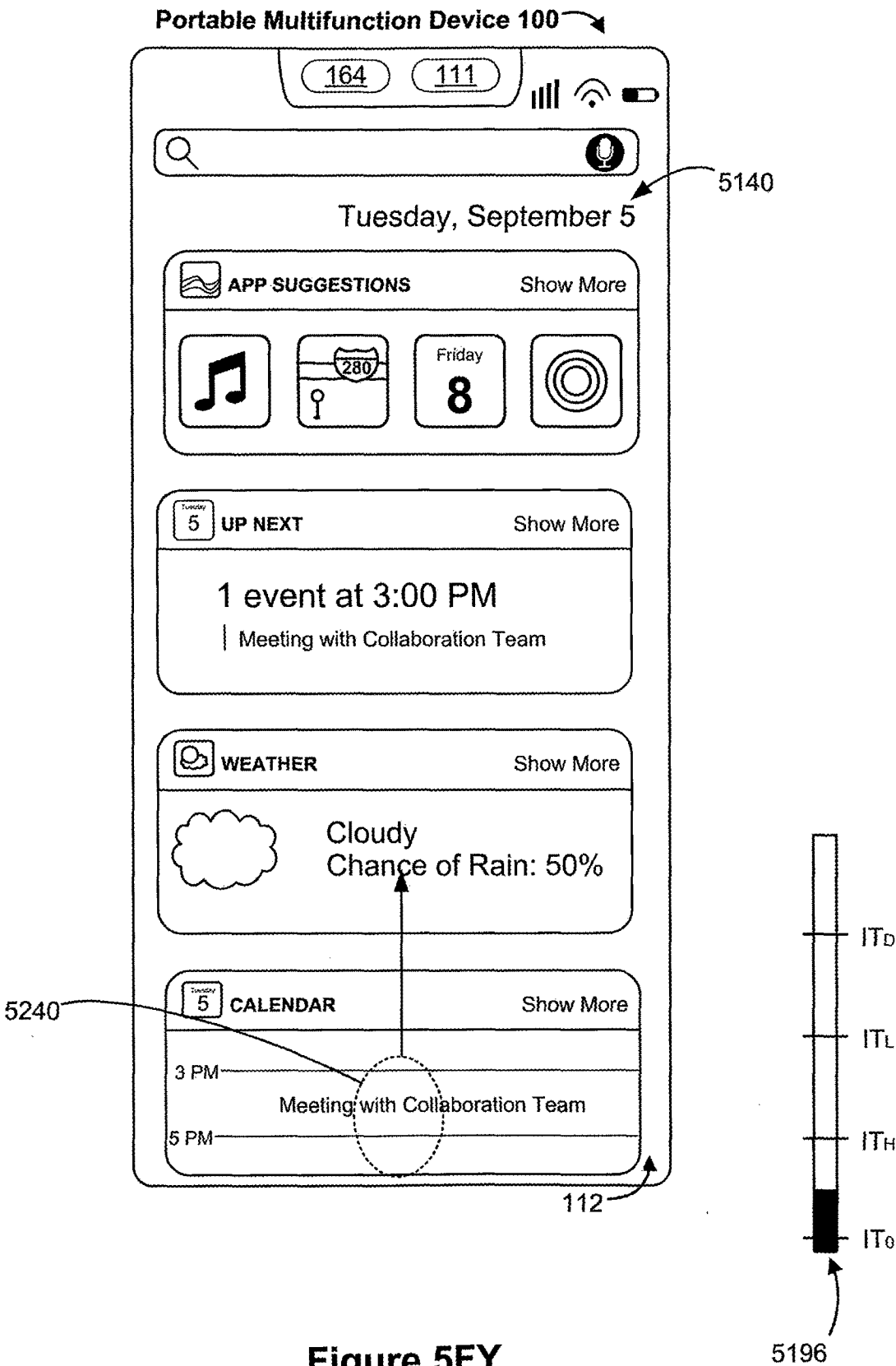
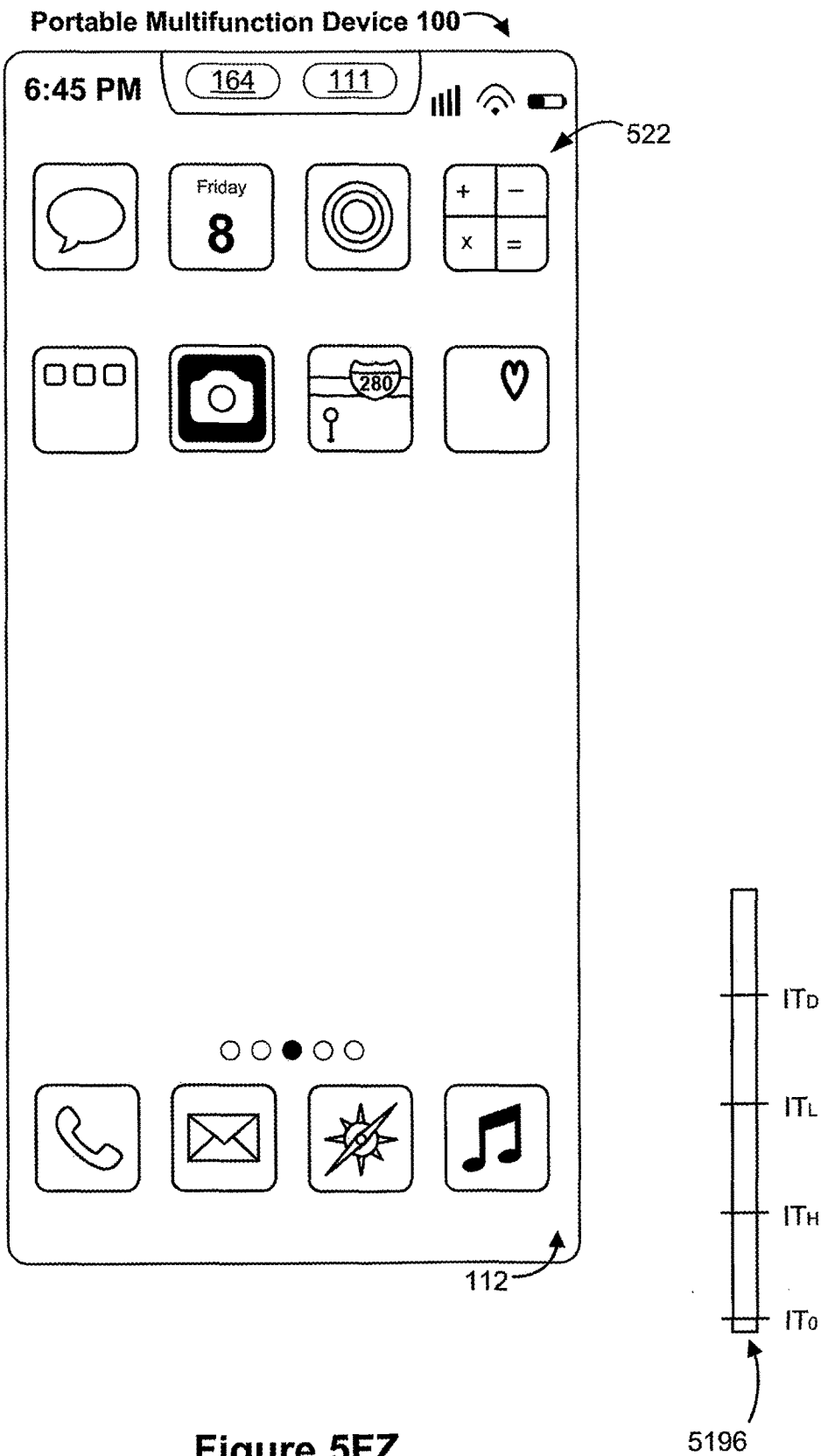


Figure 5FX





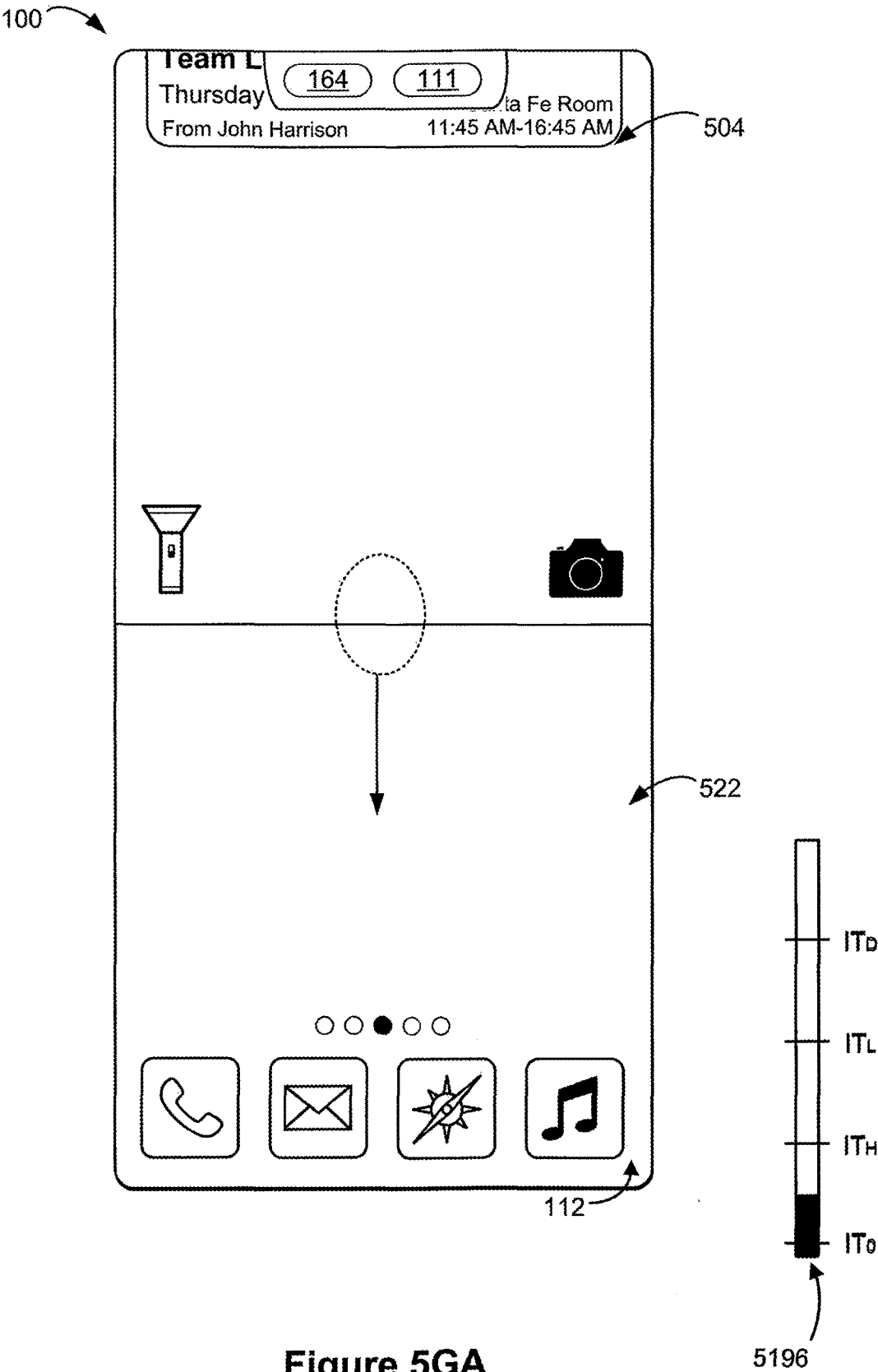


Figure 5GA



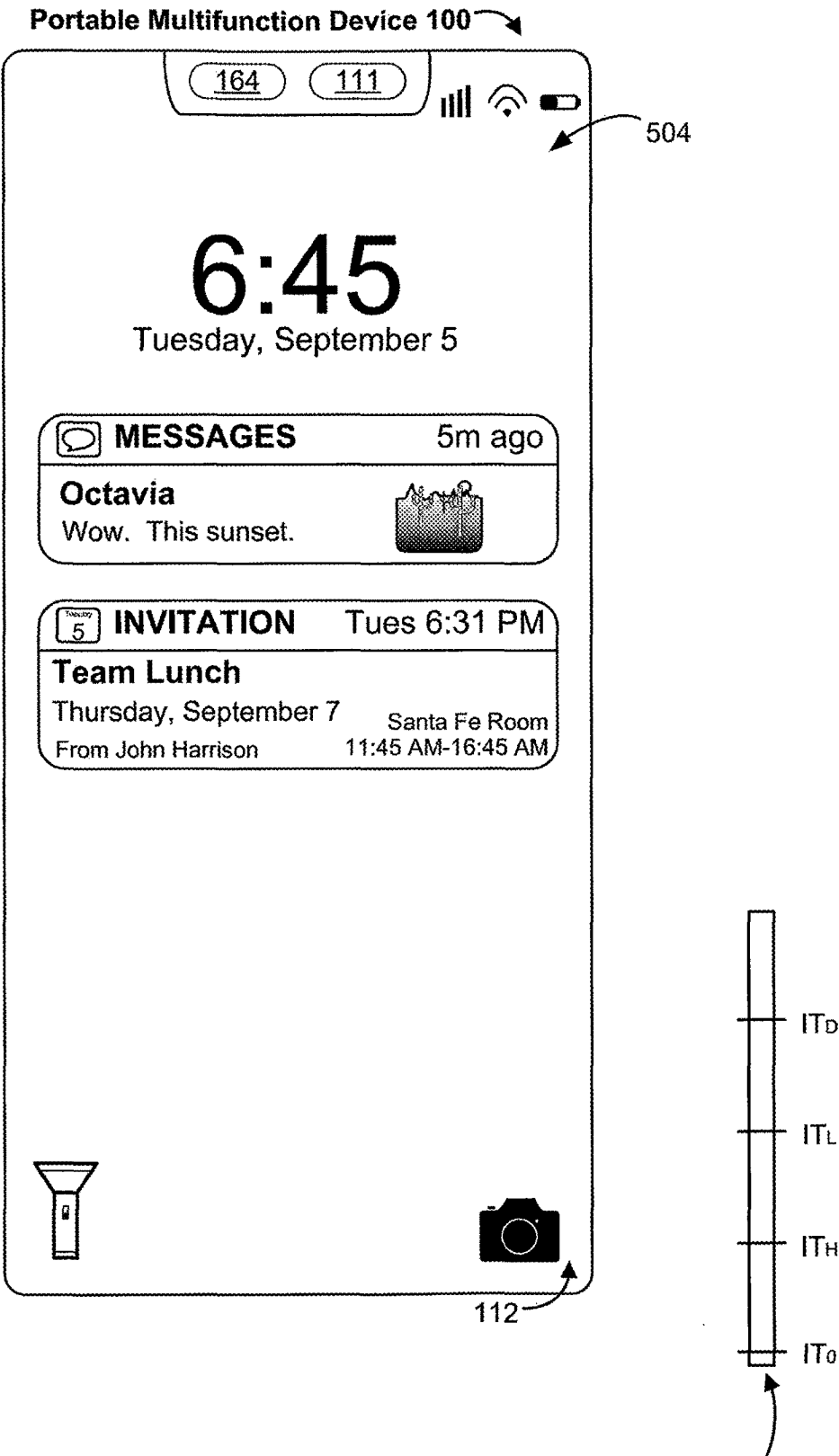


Figure 5GB

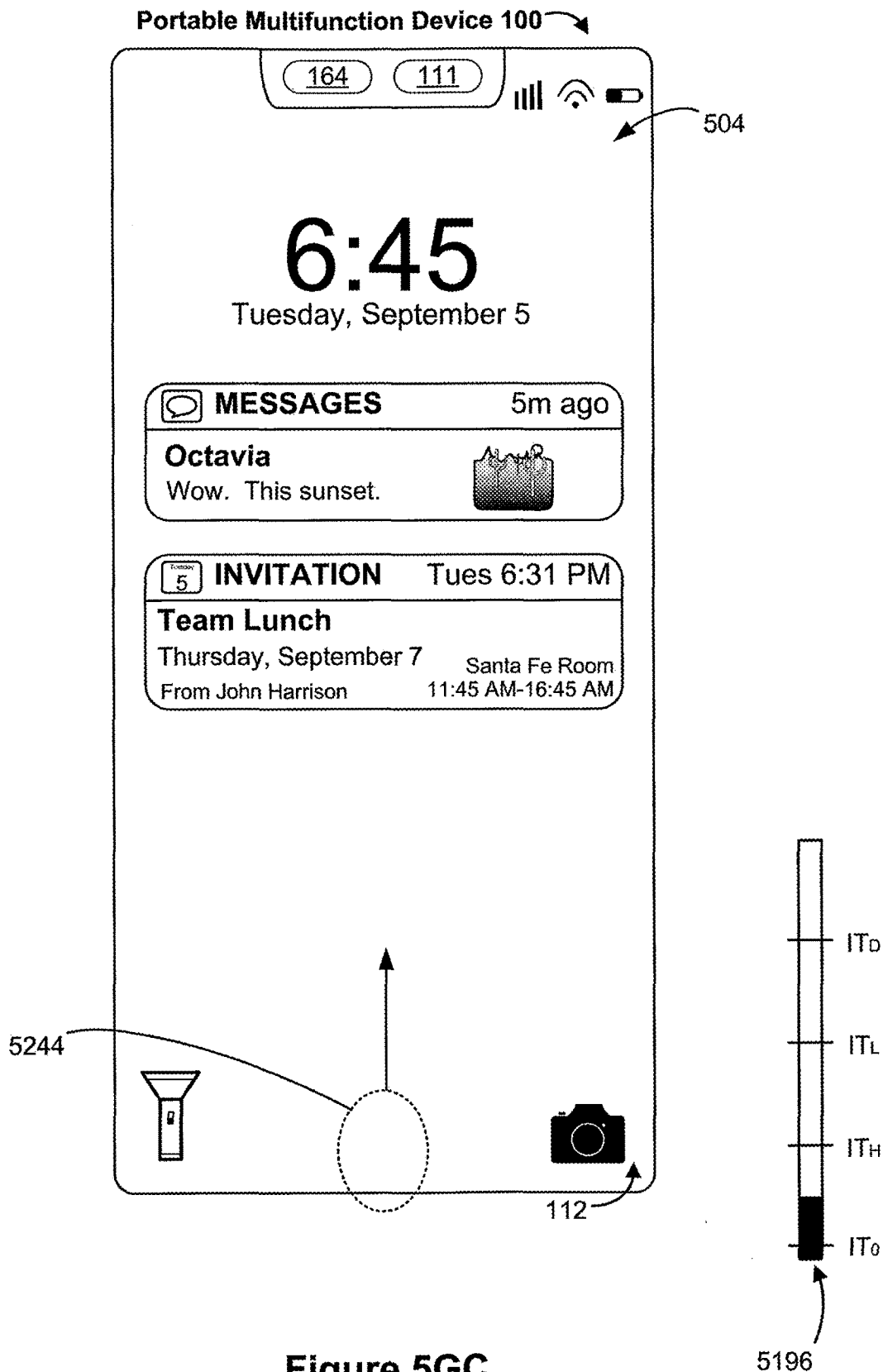
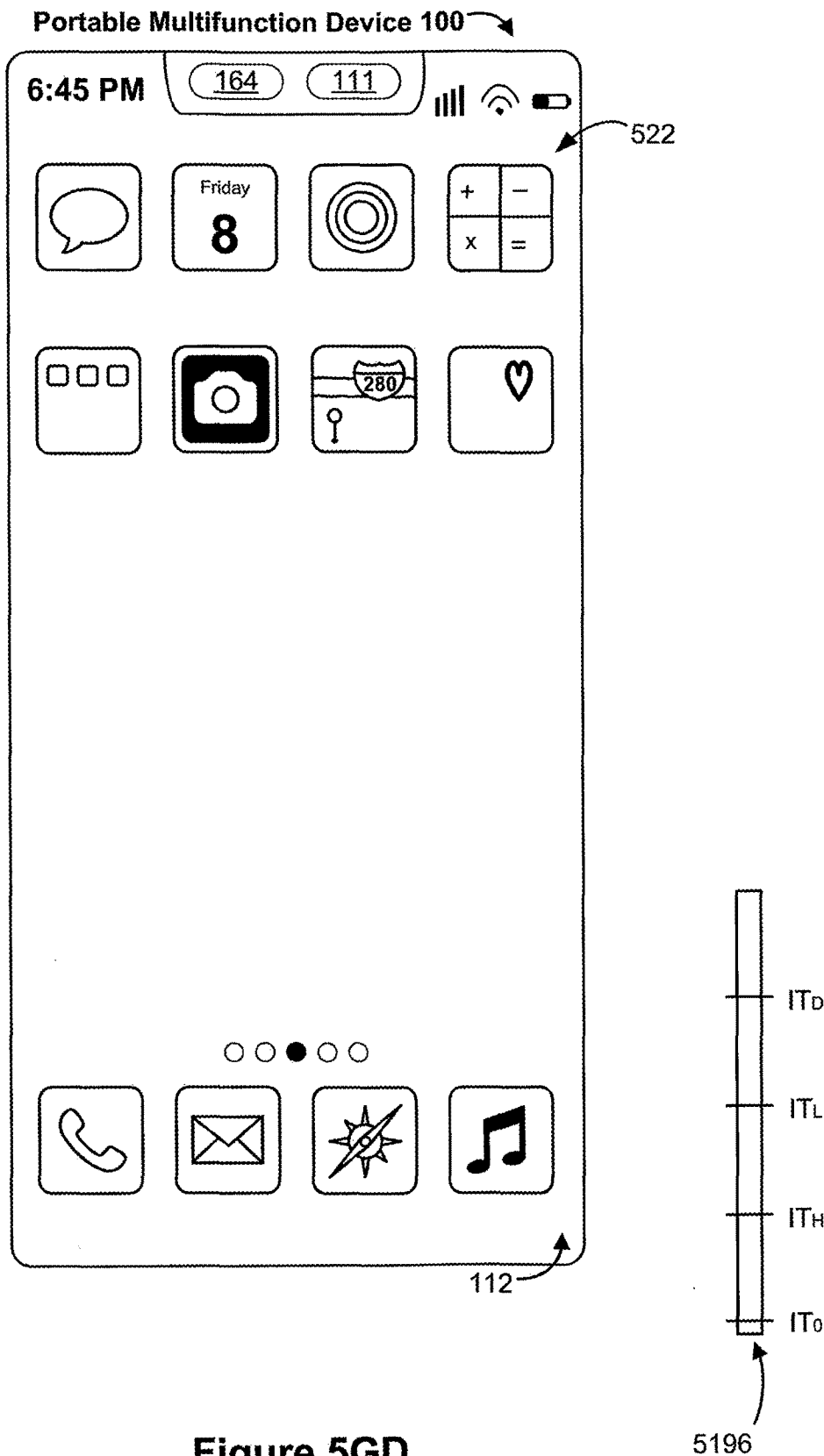
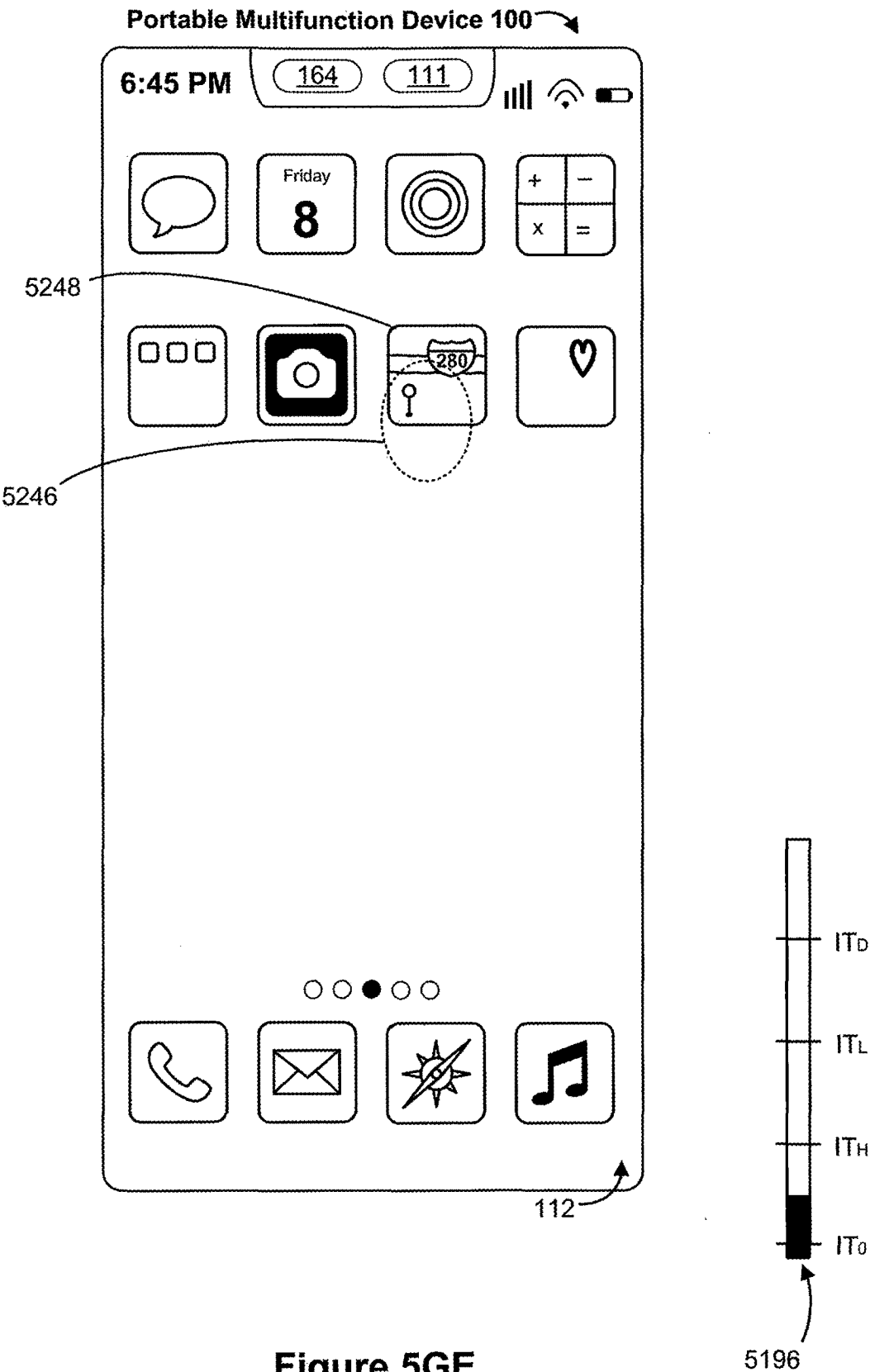


Figure 5GC





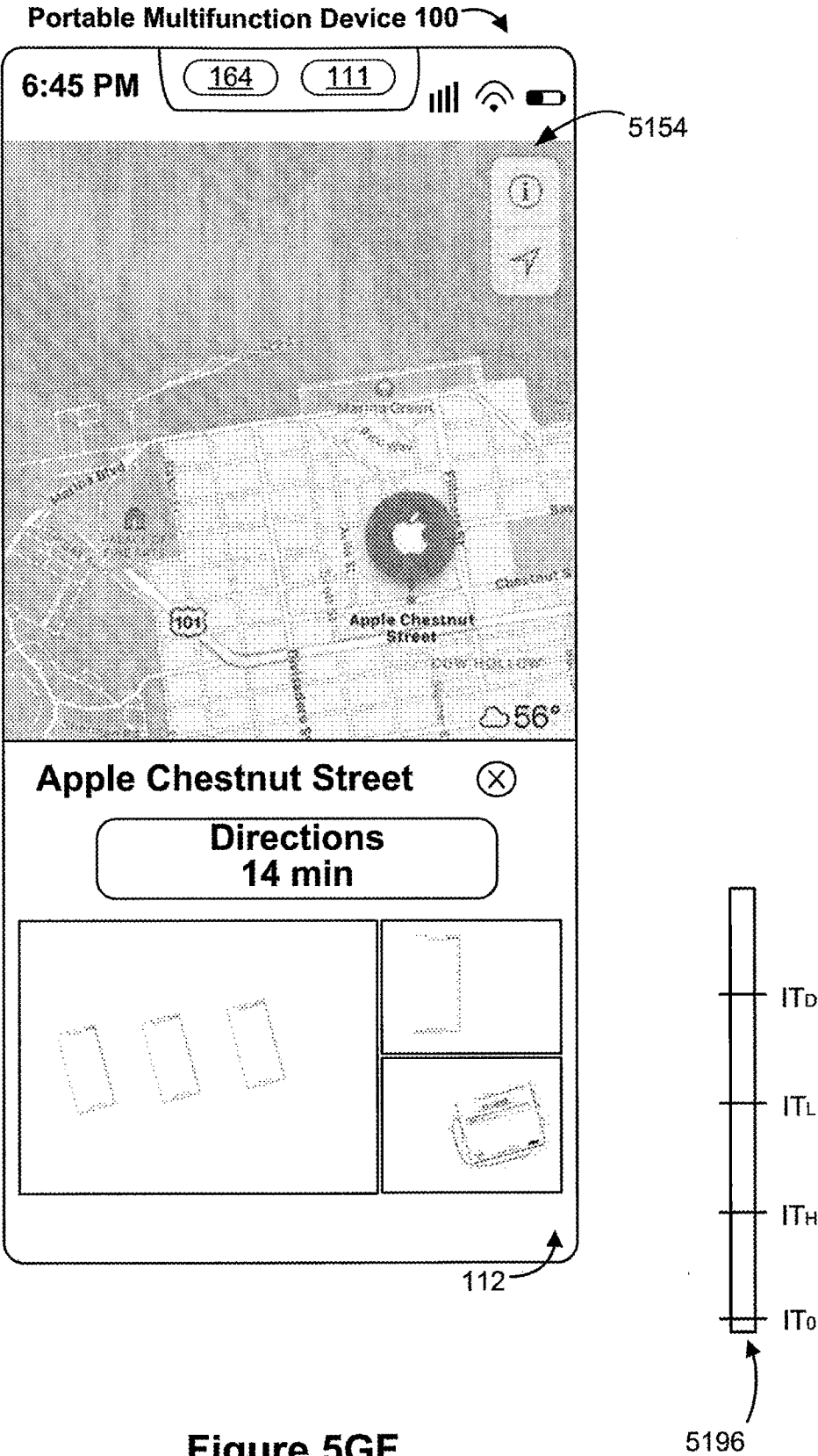


Figure 5GF

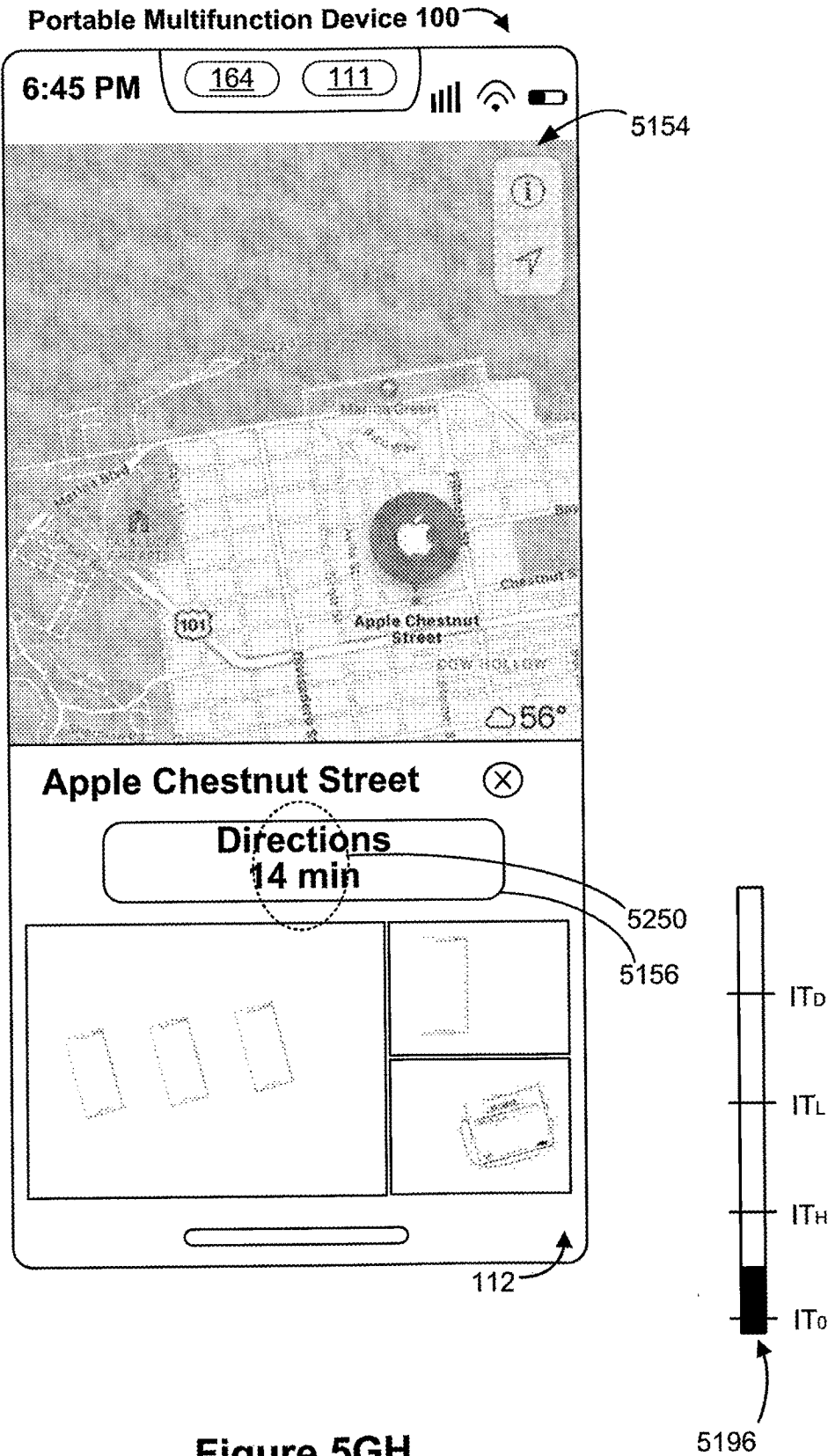


Figure 5GH

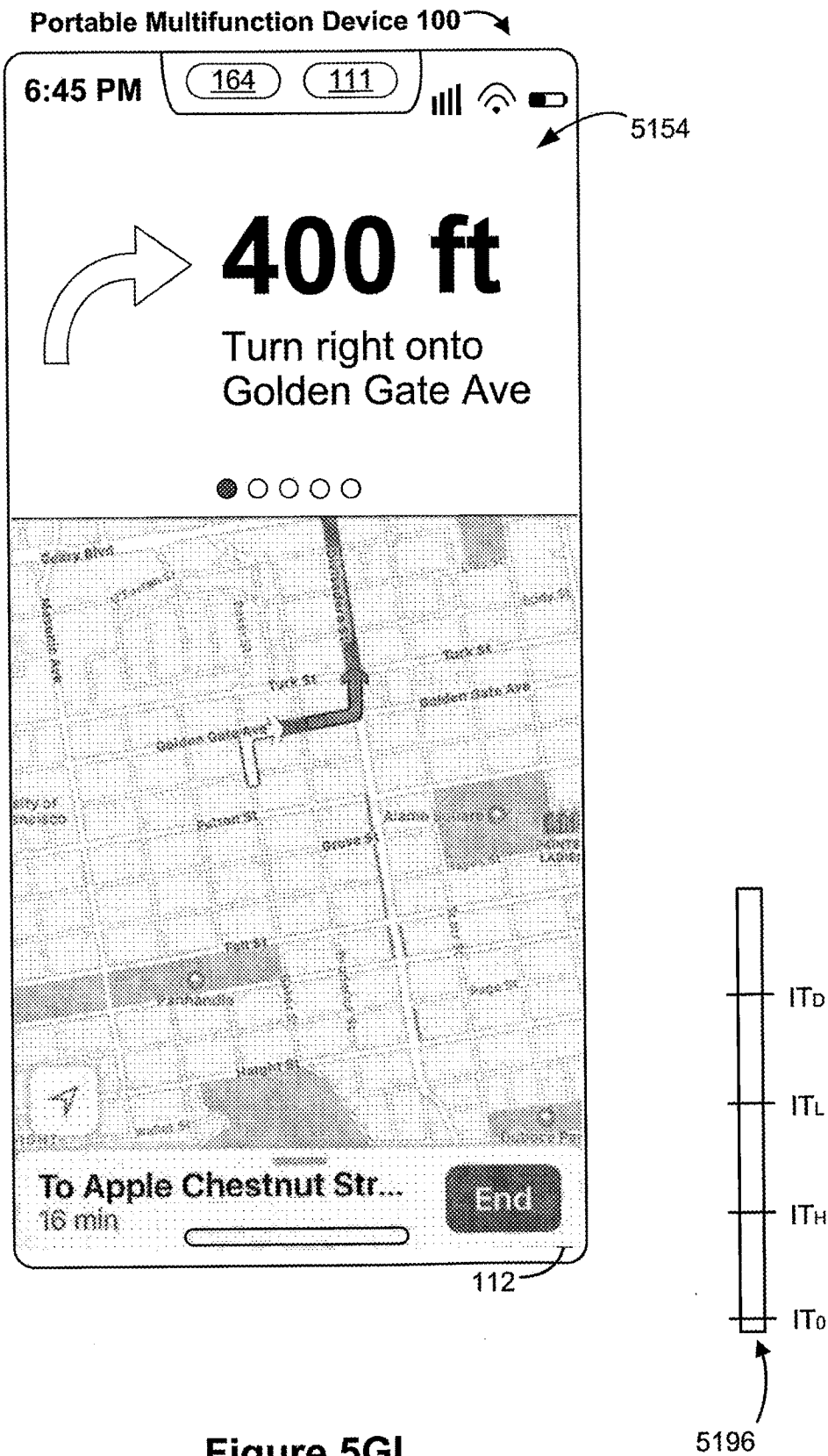


Figure 5GI



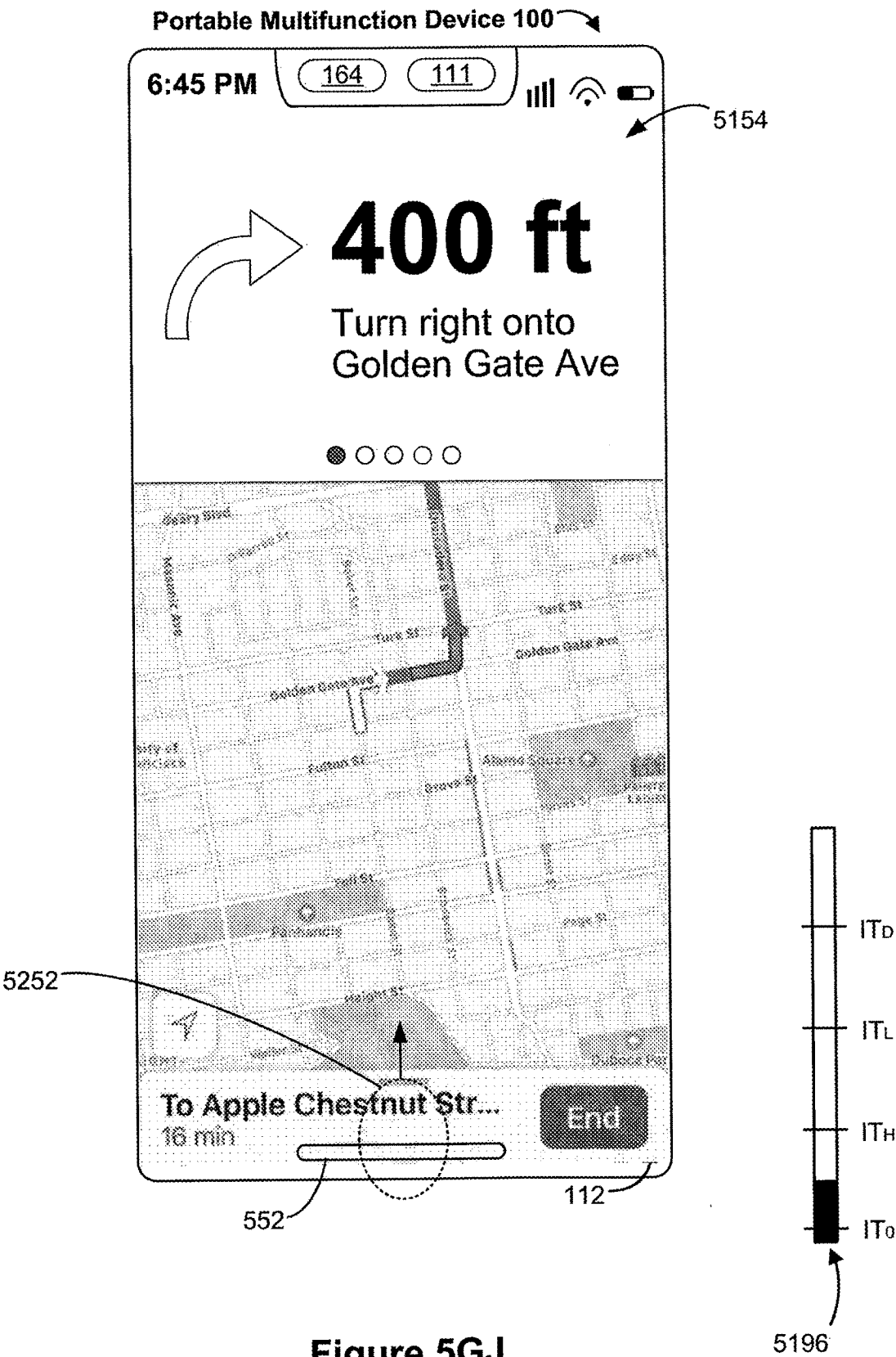


Figure 5GJ



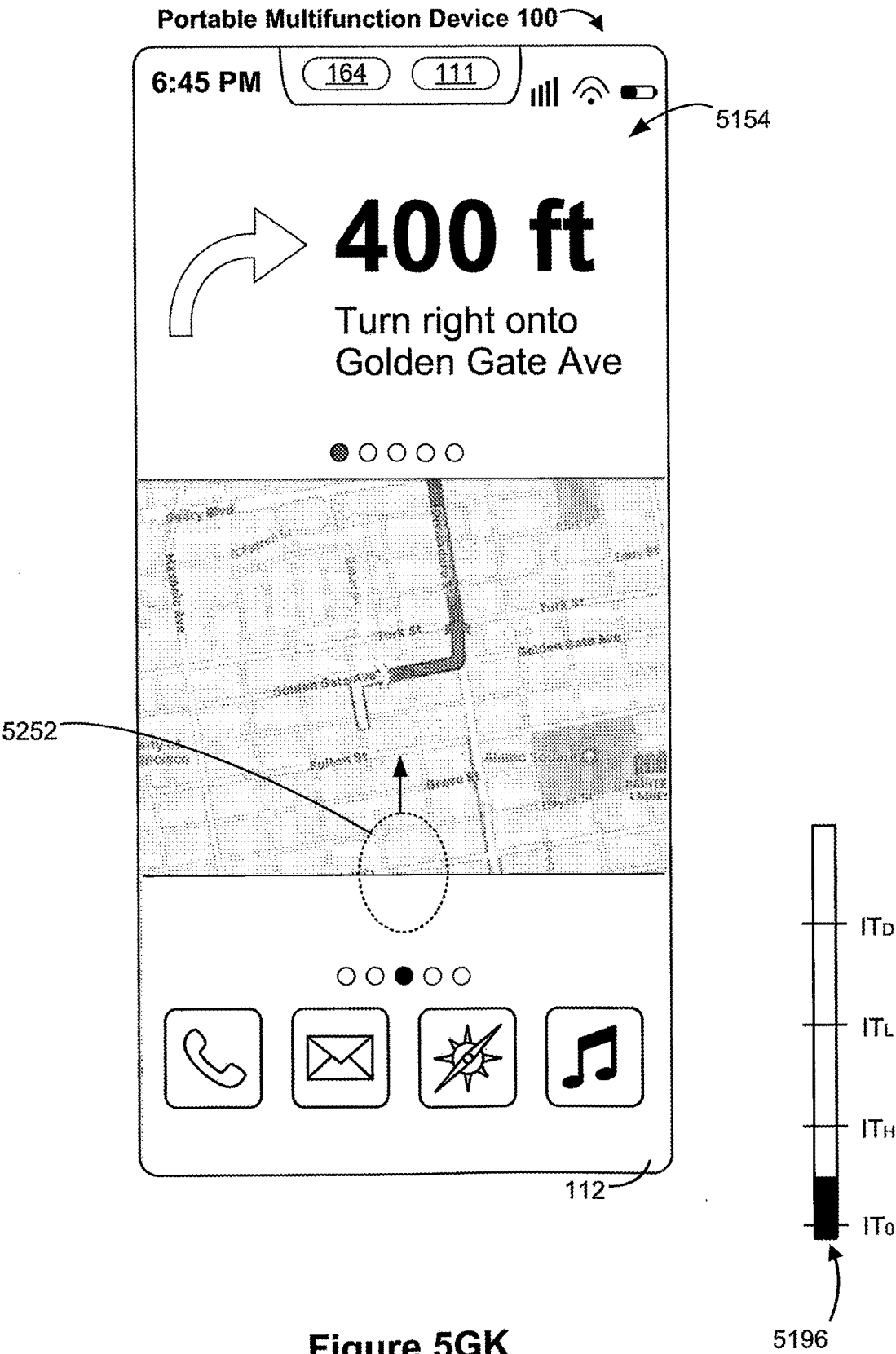


Figure 5GK

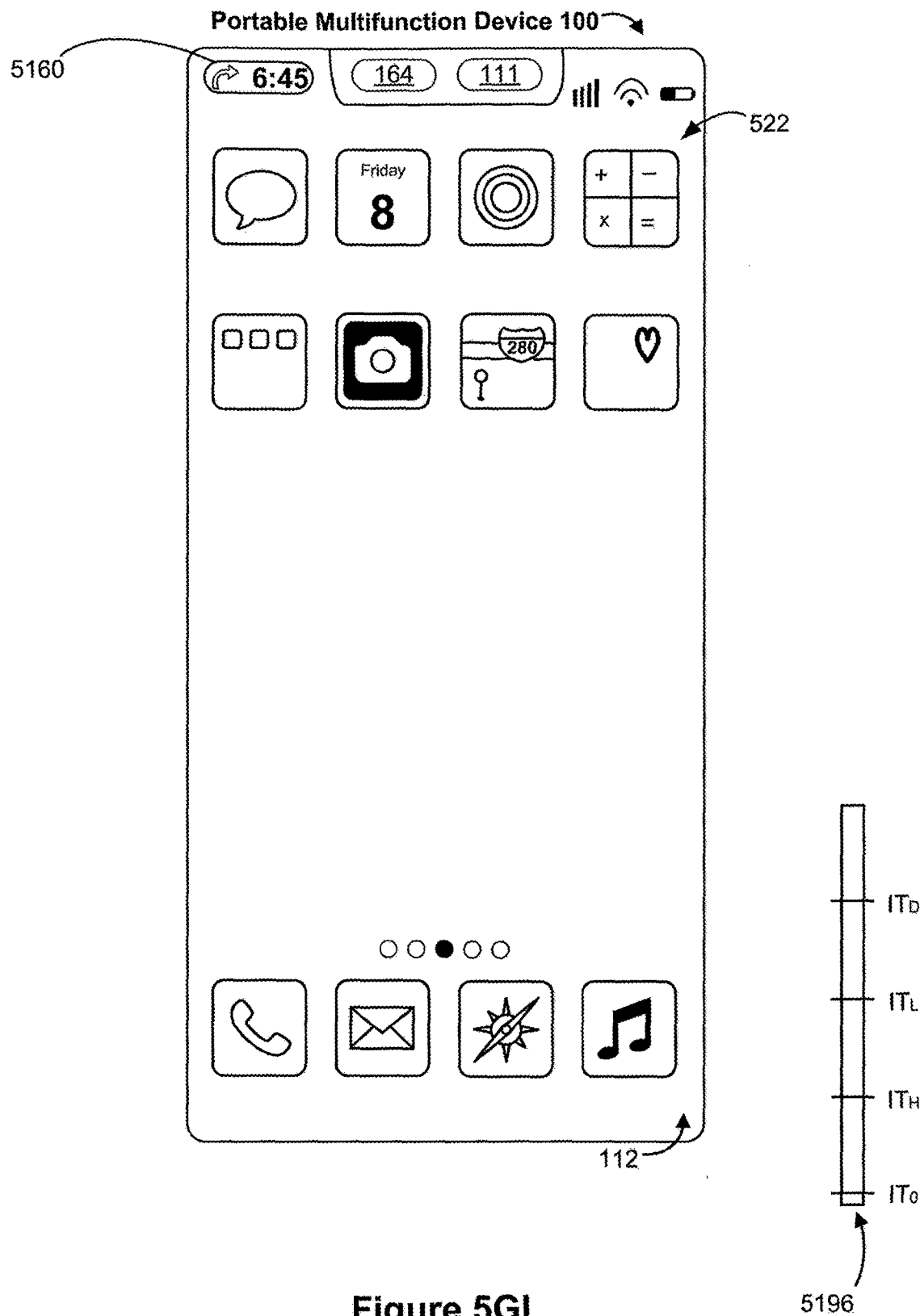
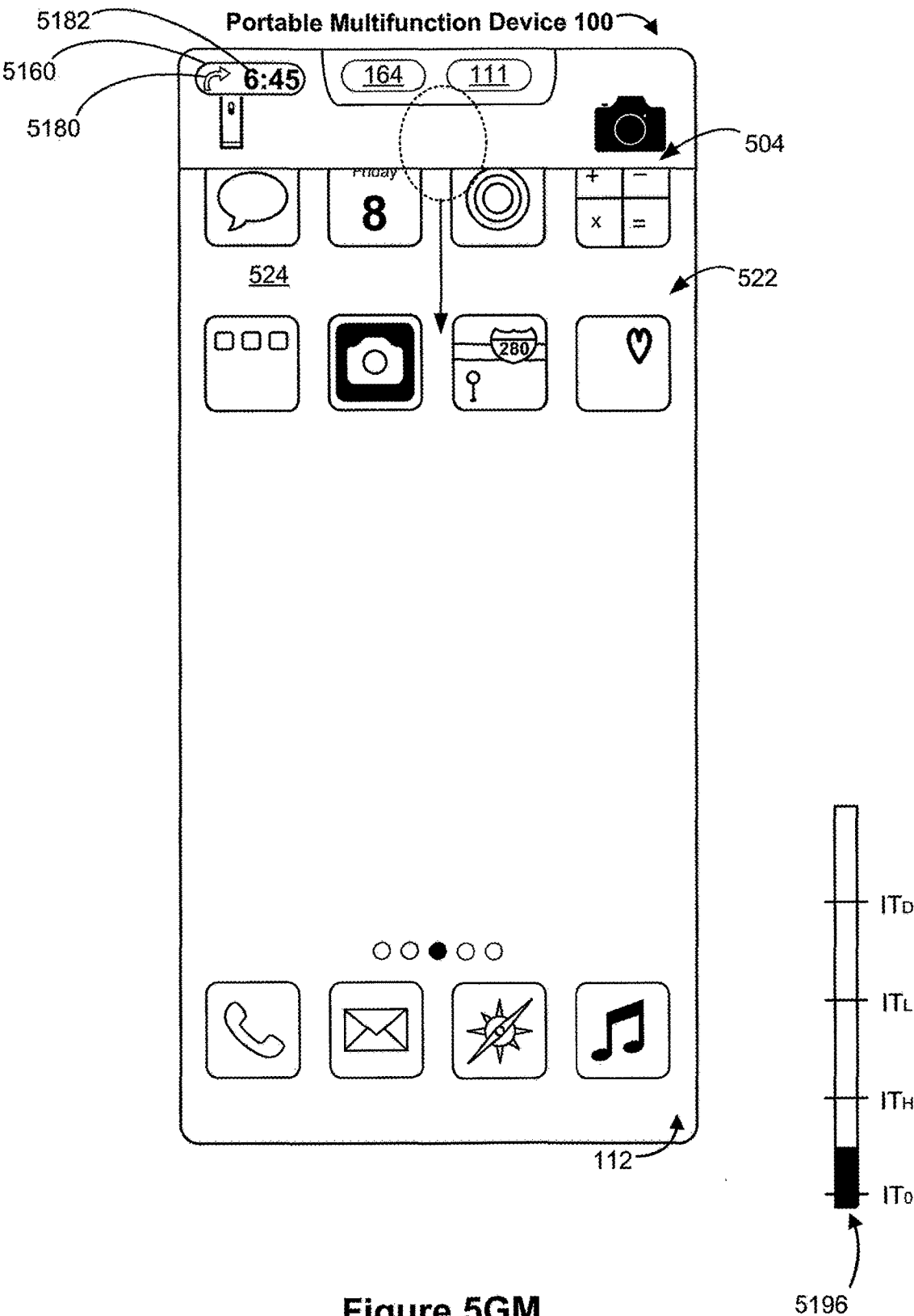


Figure 5GL



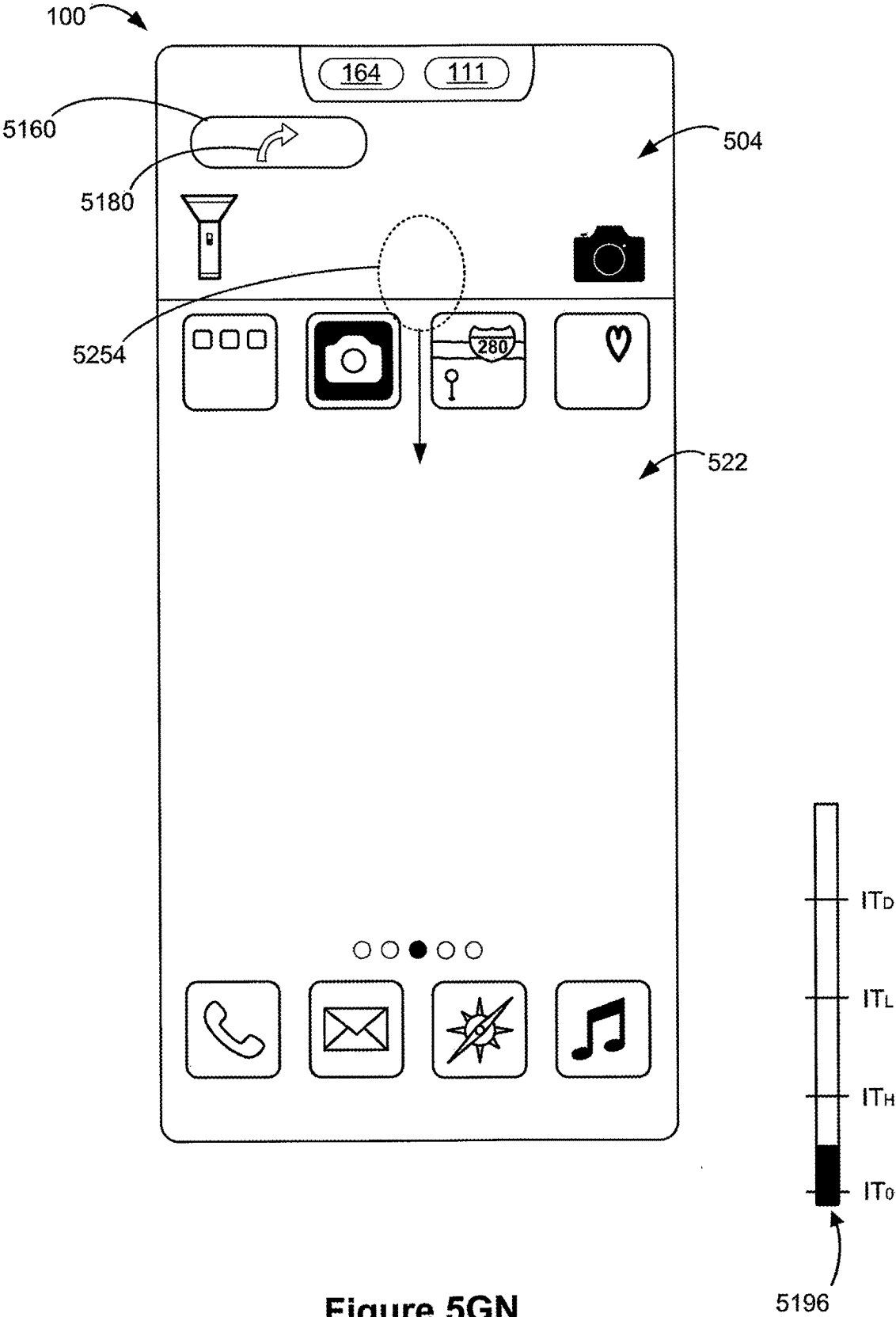


Figure 5GN

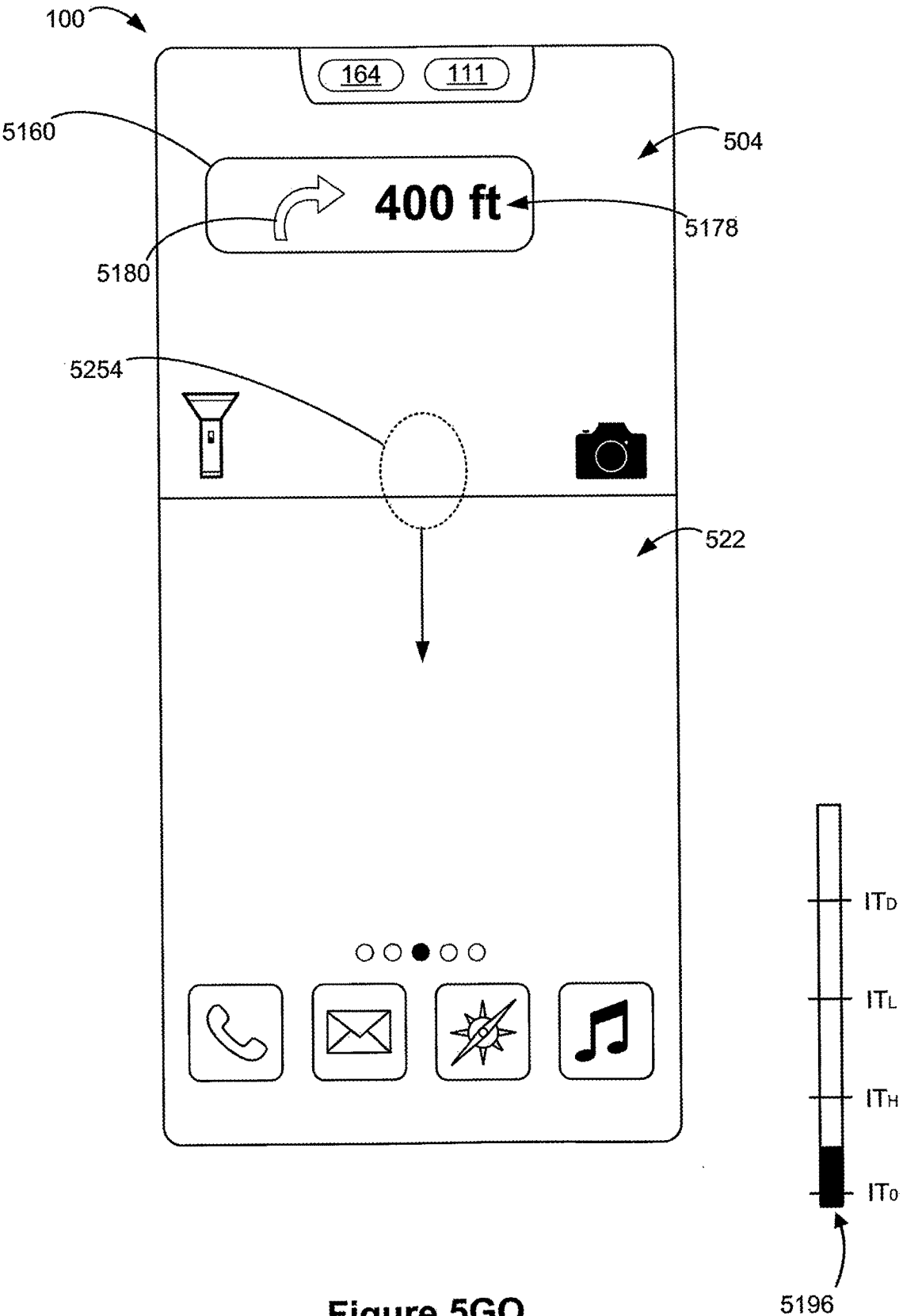
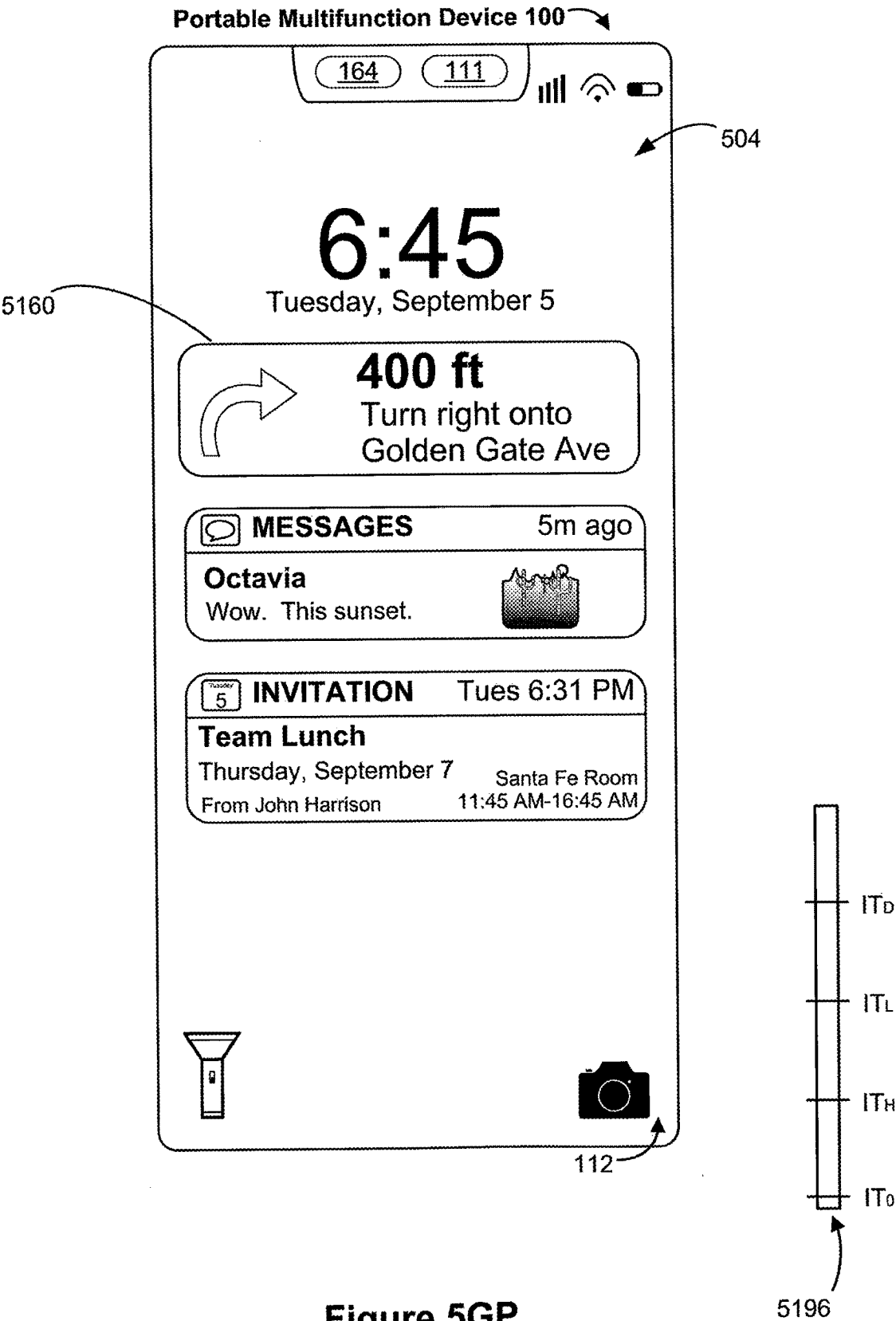


Figure 5GO



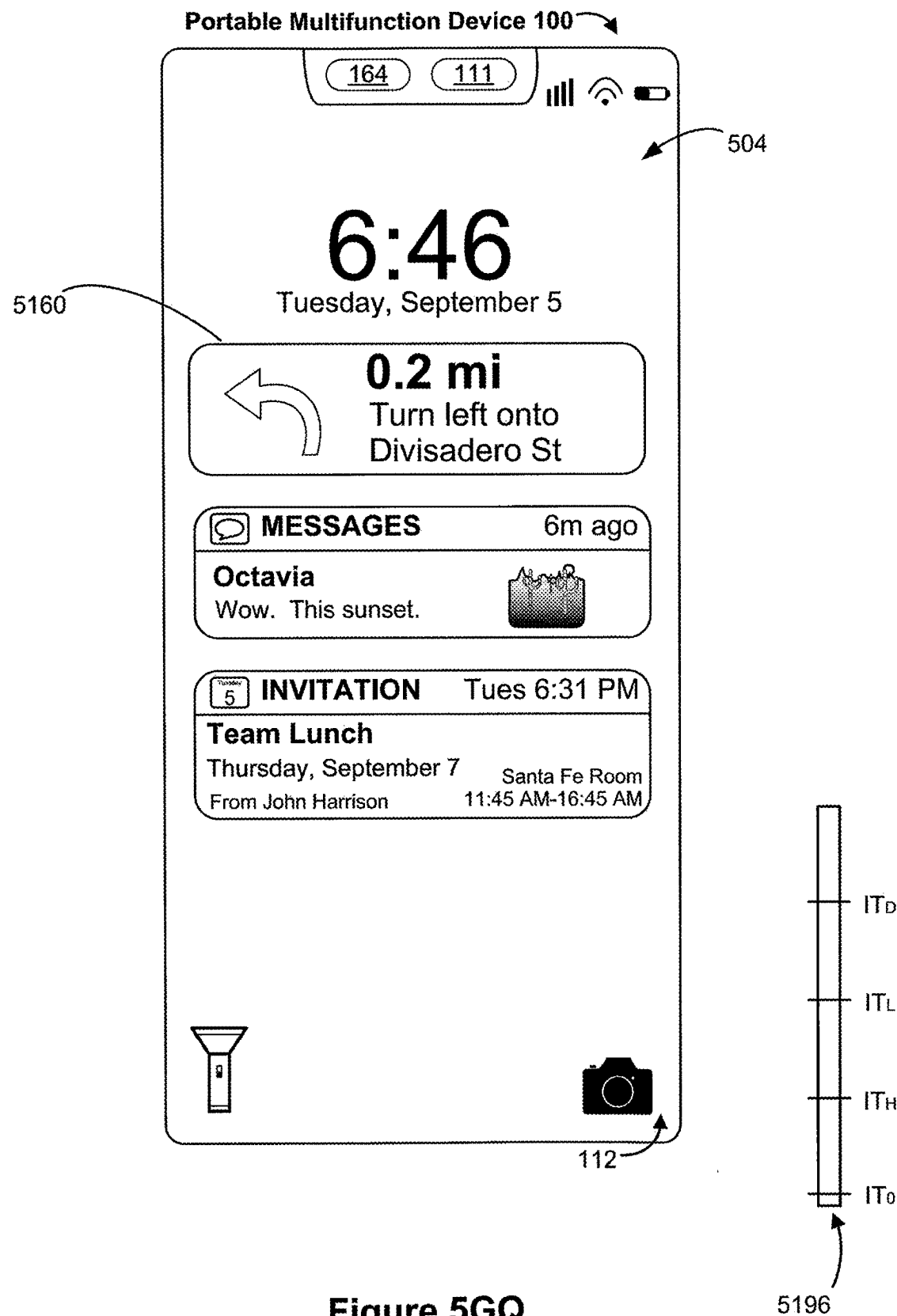
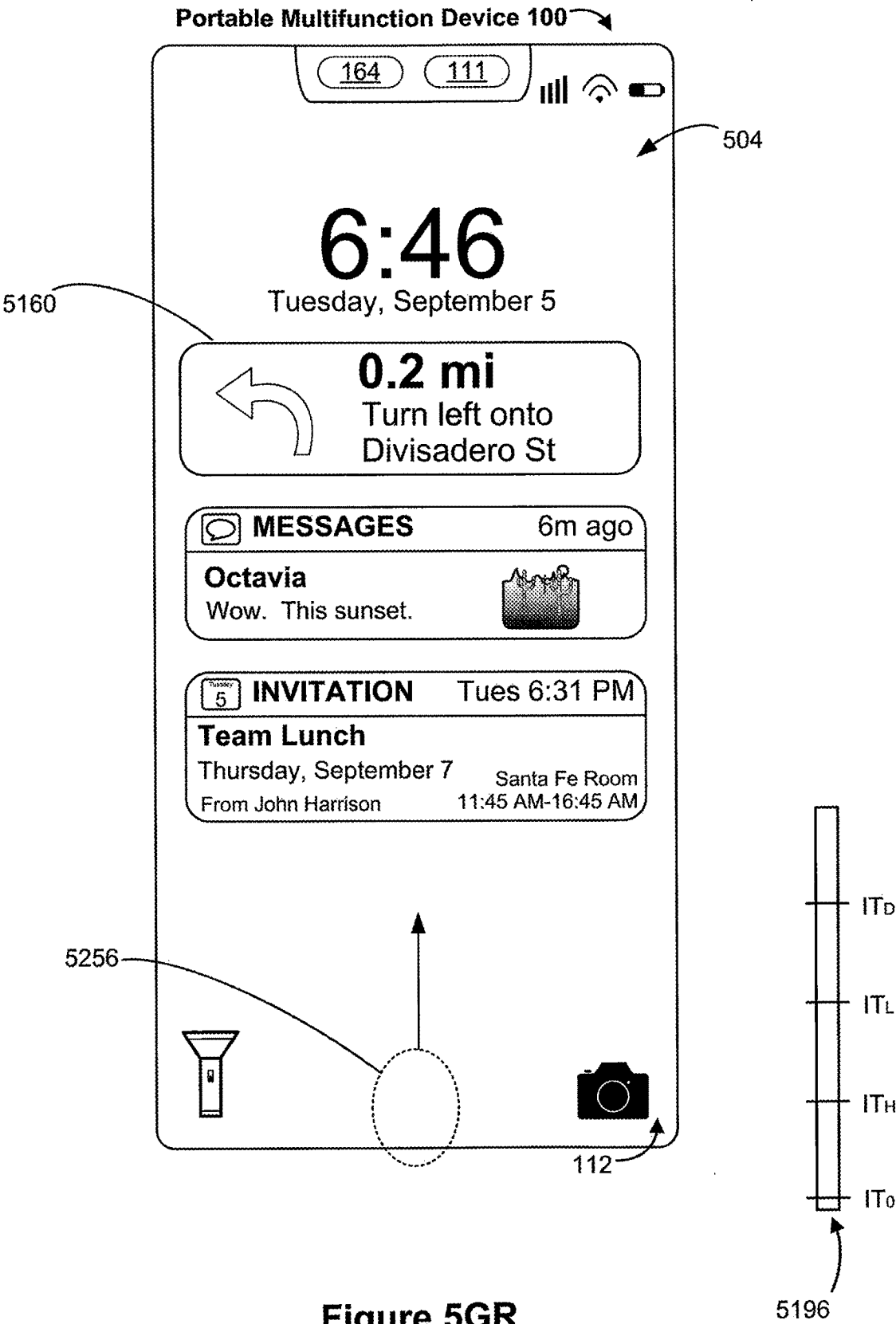


Figure 5GQ





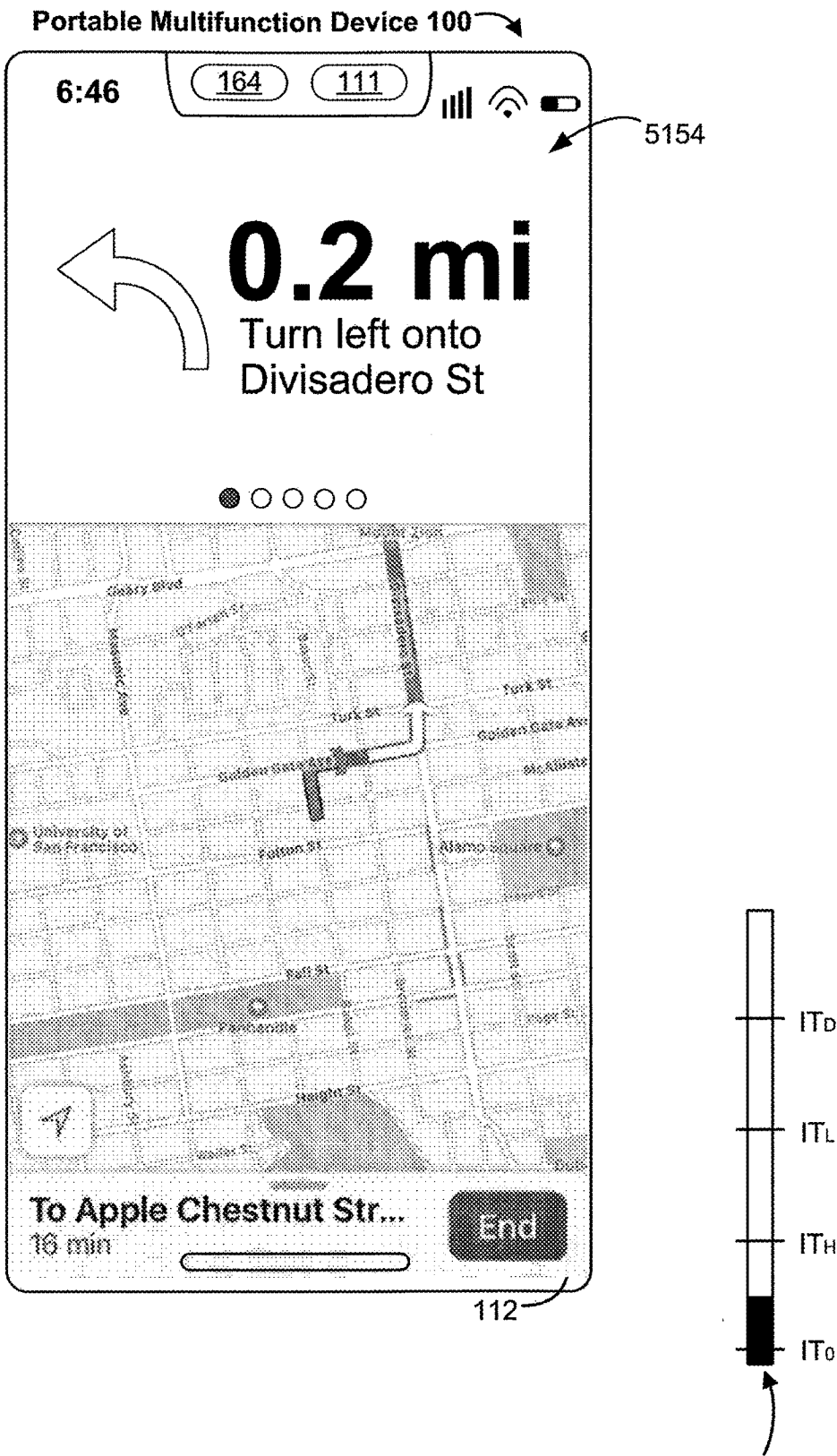


Figure 5GS

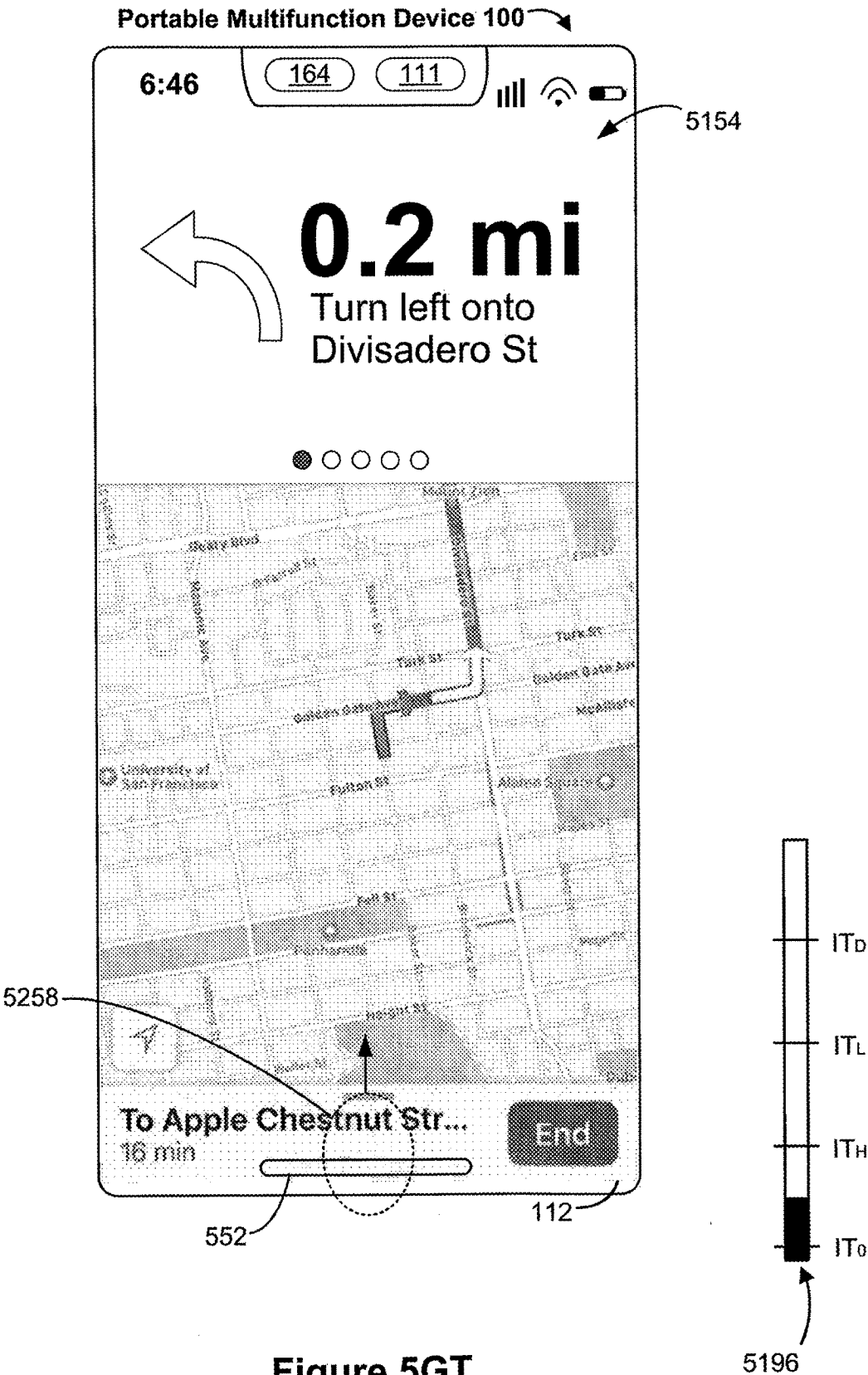
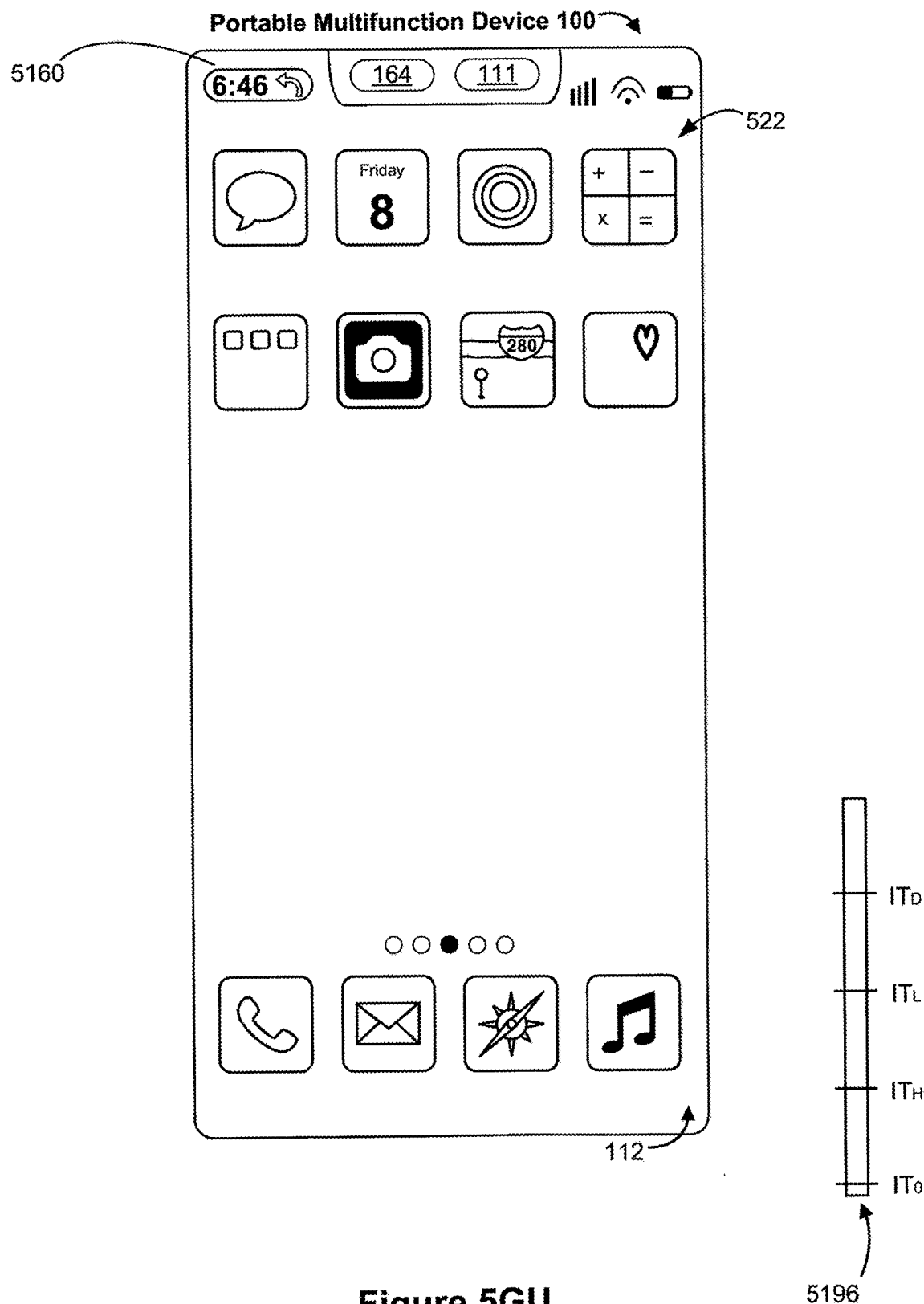


Figure 5GT



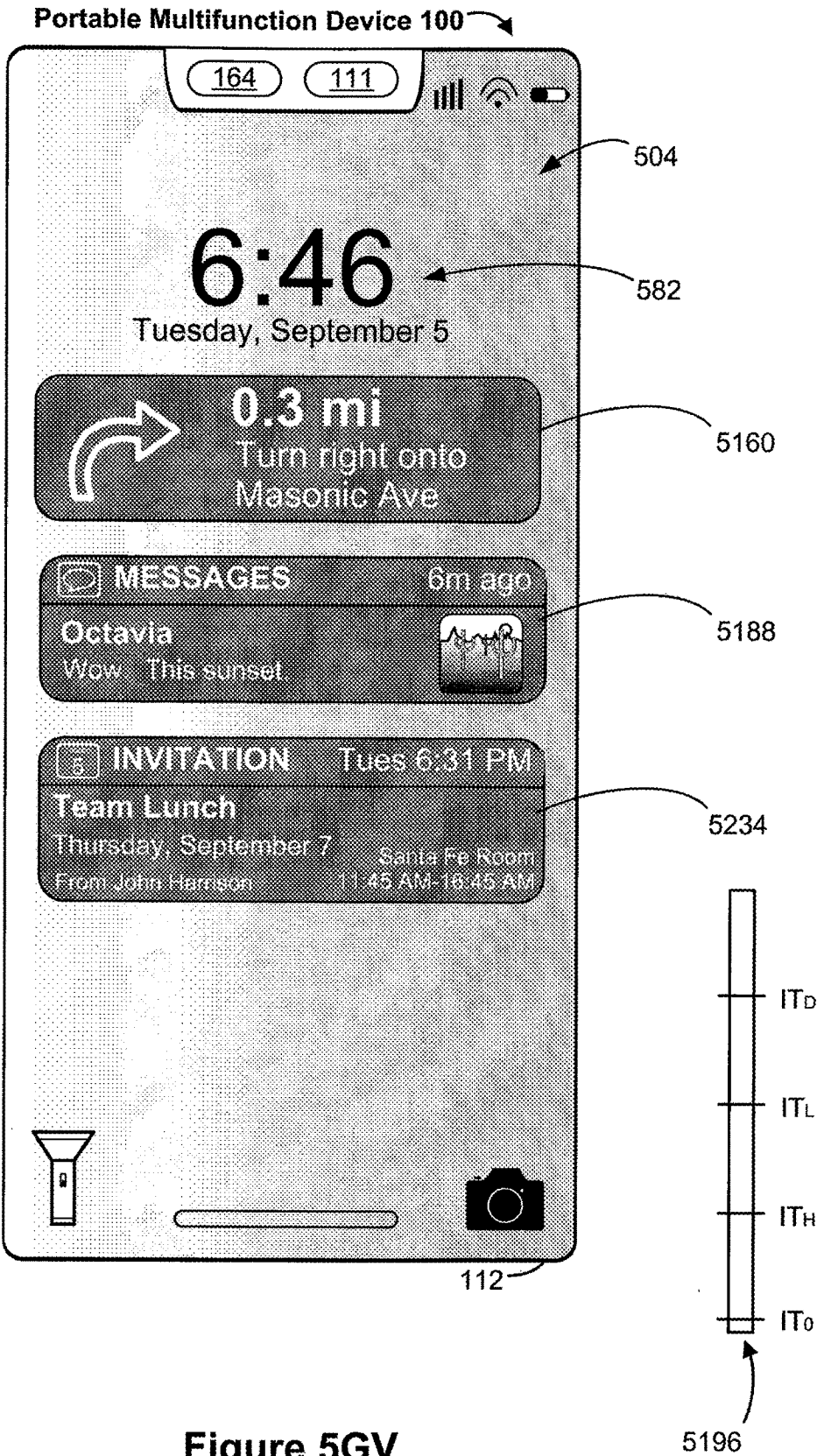


Figure 5GV

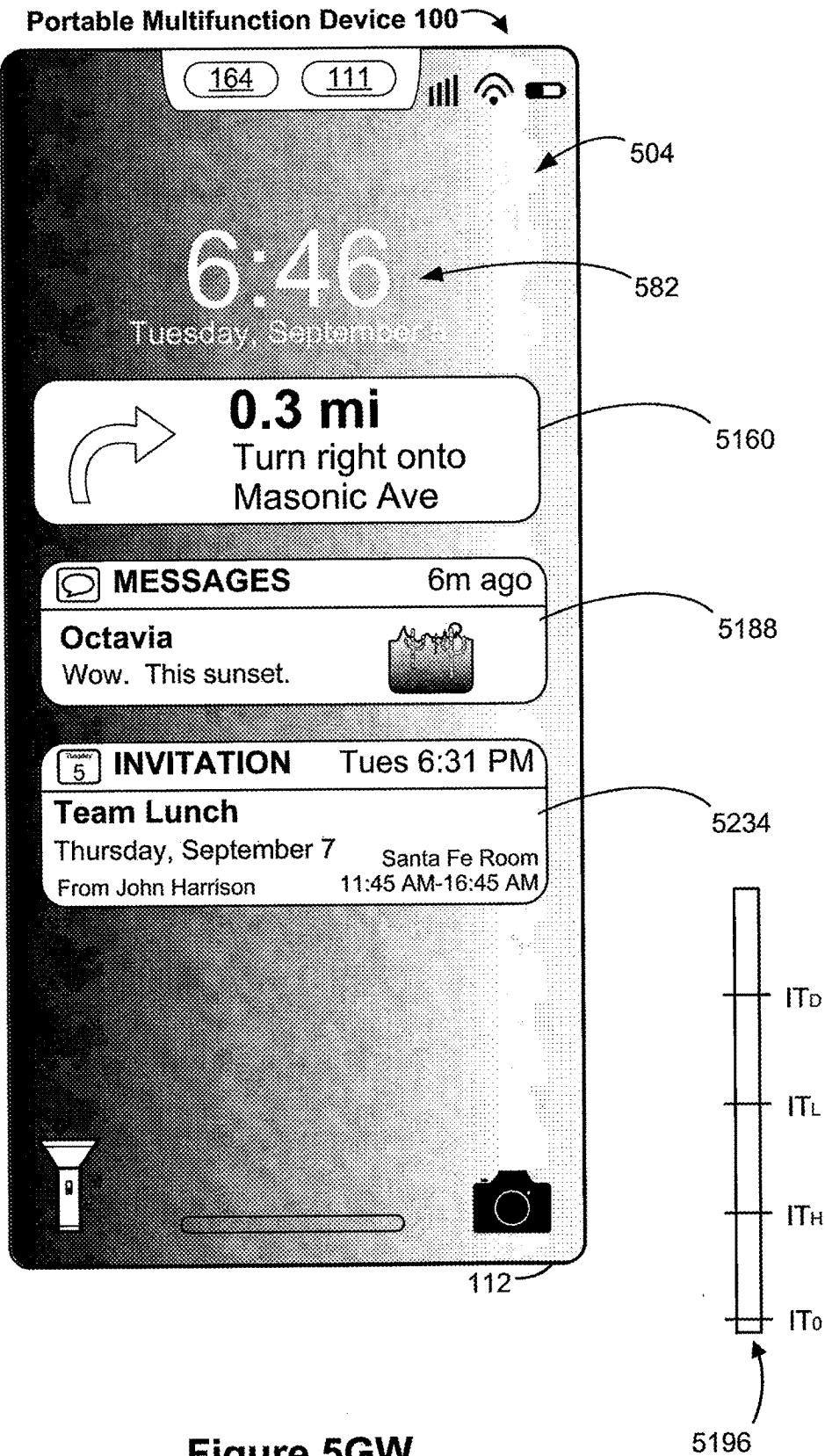


Figure 5GW



Portable Multifunction Device 100

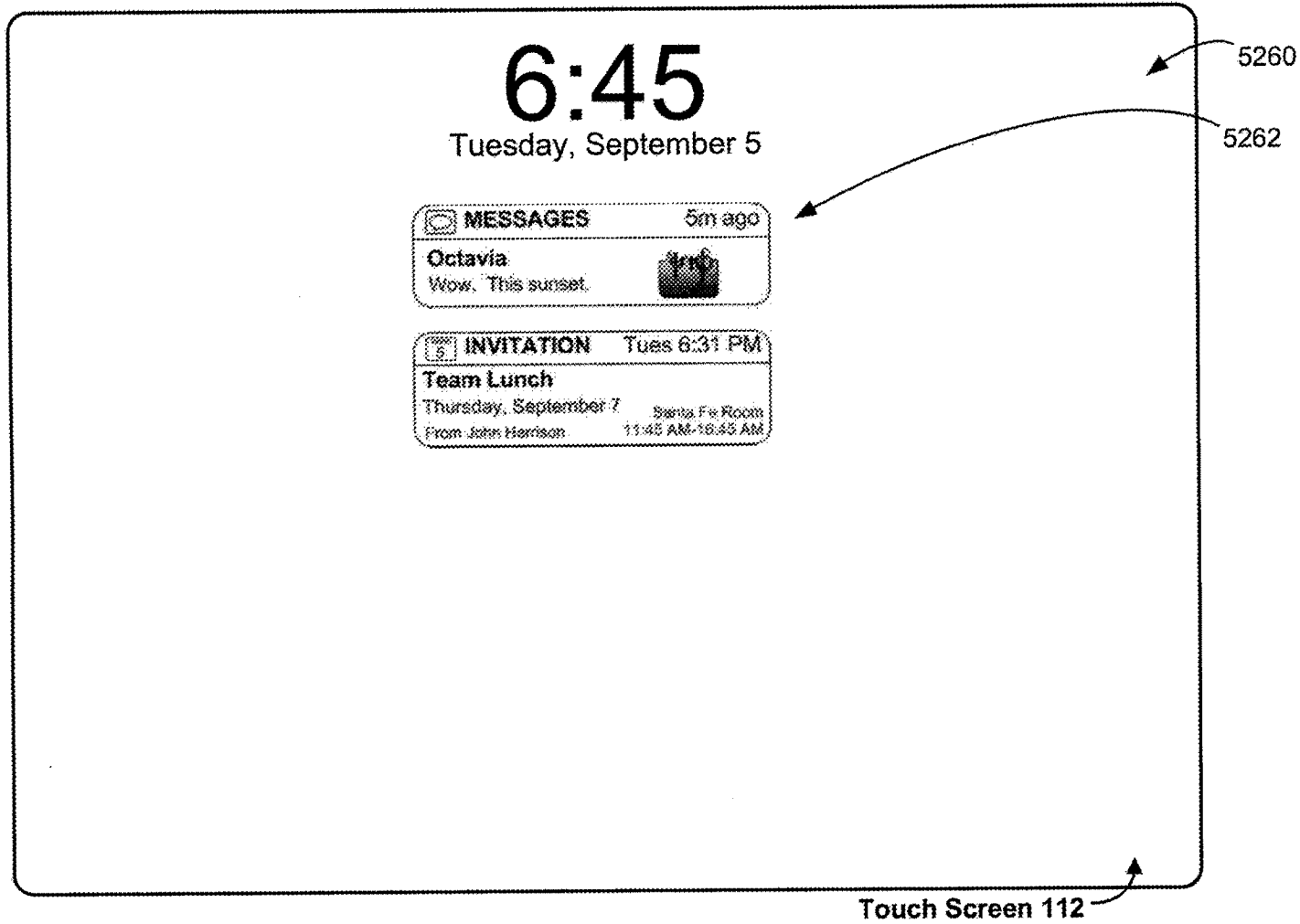


Figure 5GX

Portable Multifunction Device 100

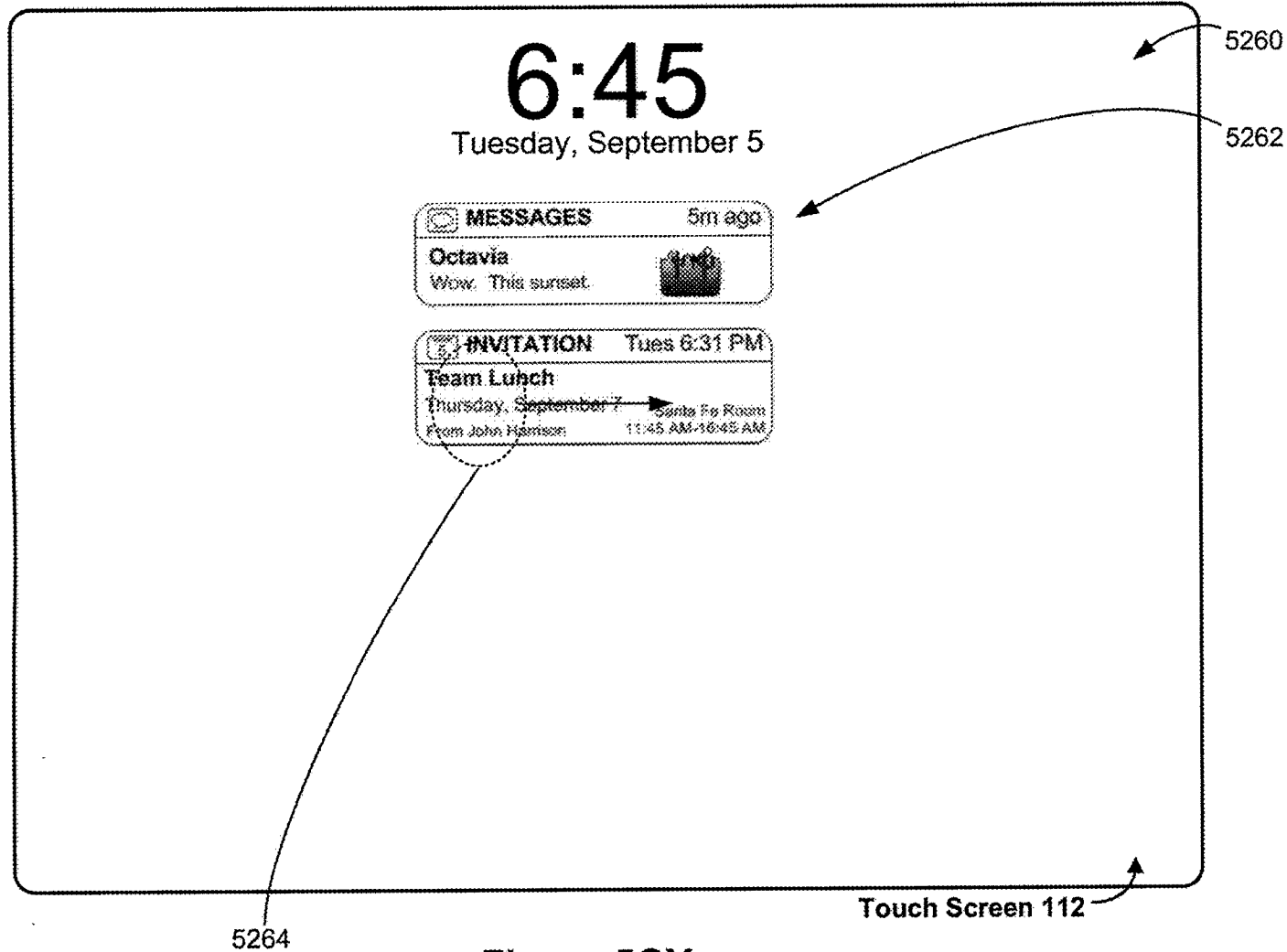
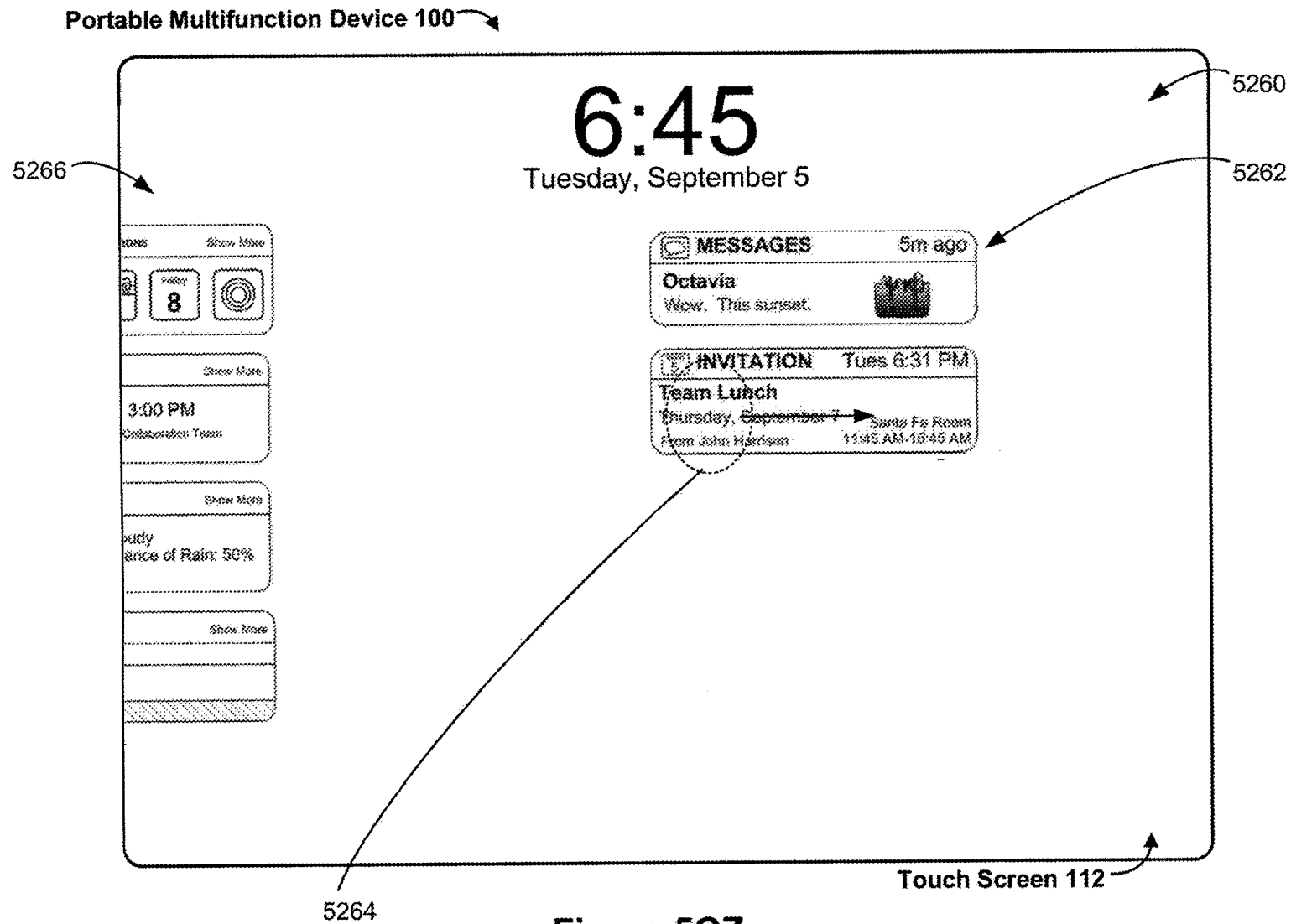


Figure 5GY





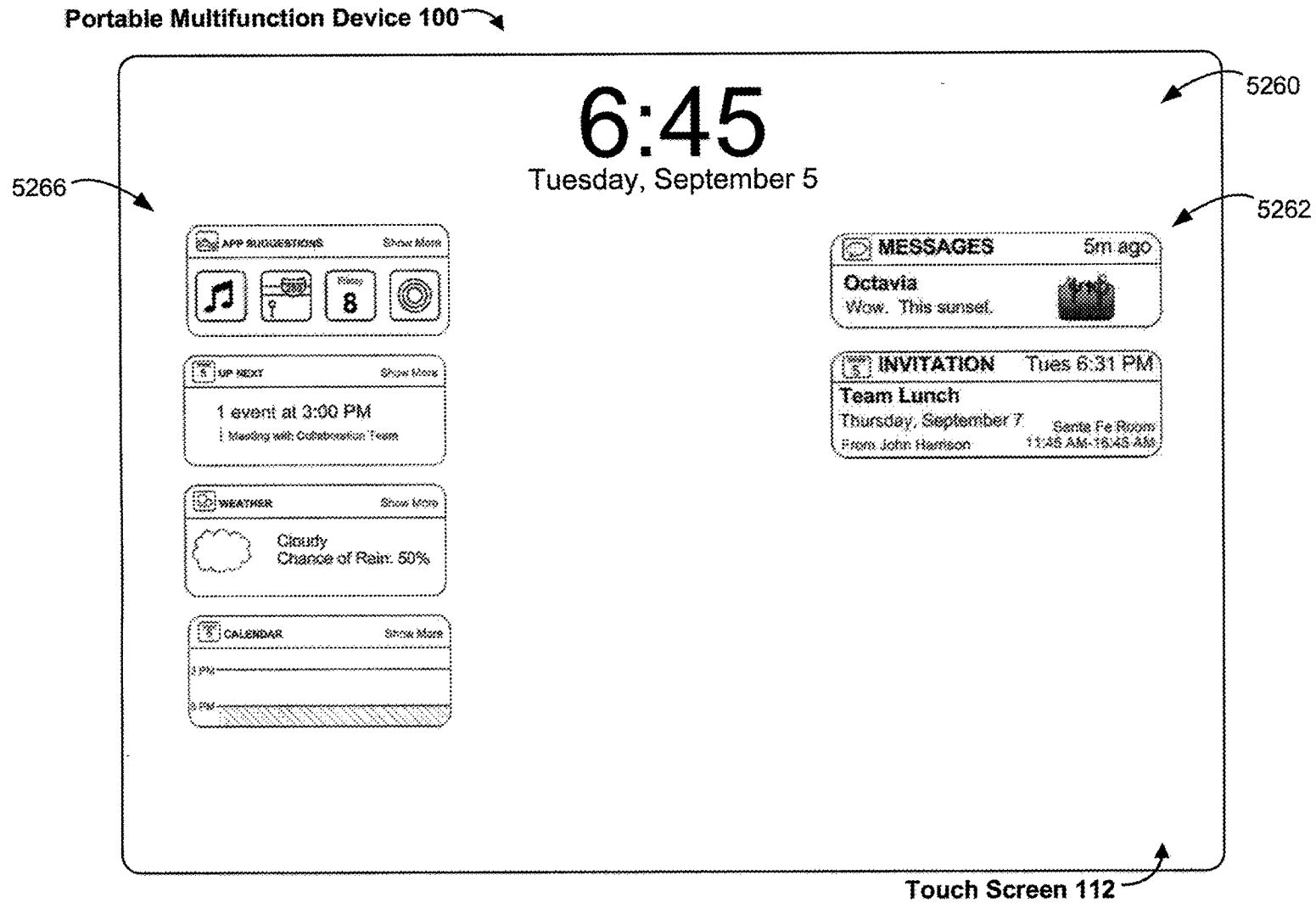


Figure 5HA

Portable Multifunction Device 100

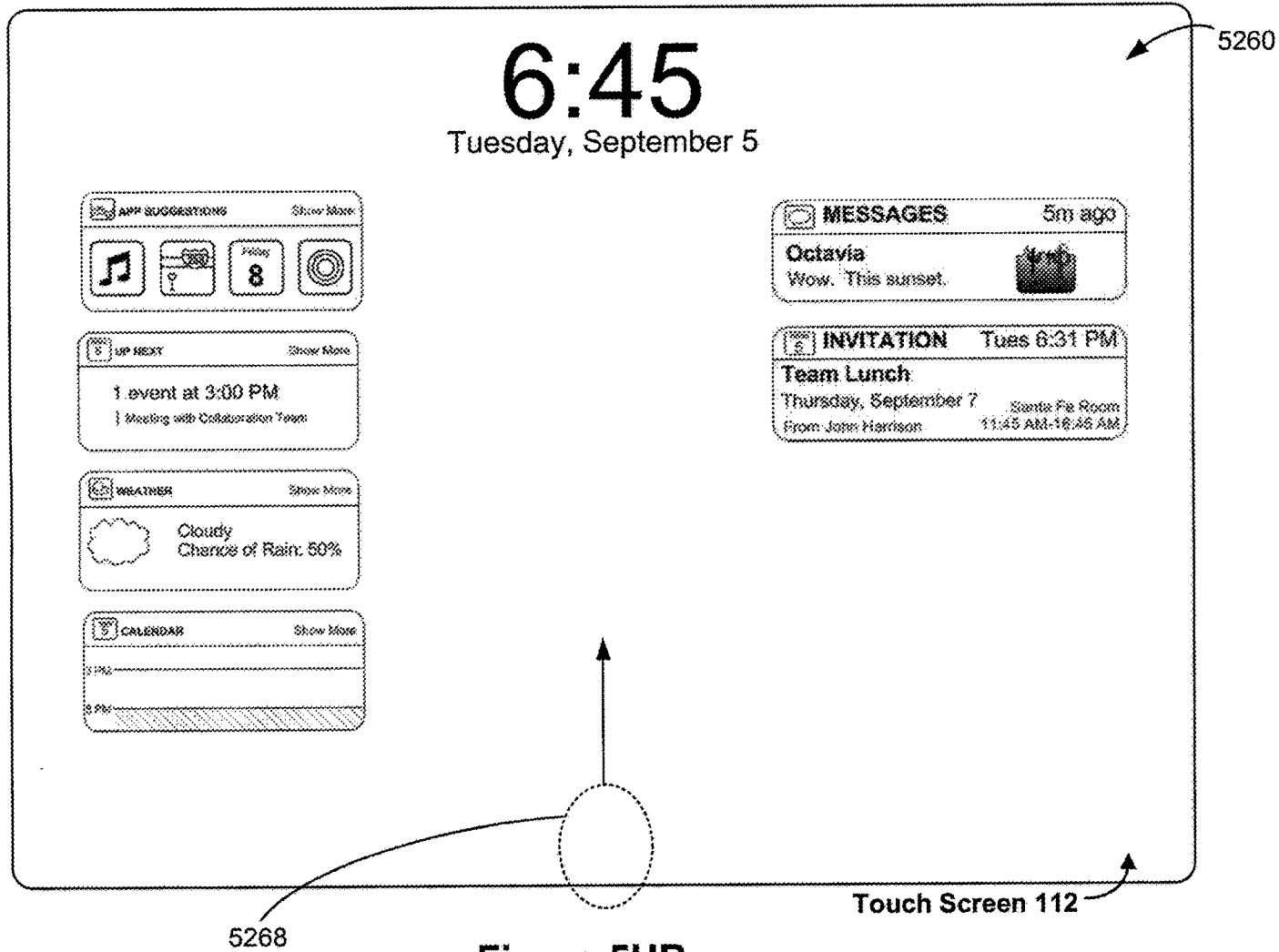


Figure 5HB

Portable Multifunction Device 100

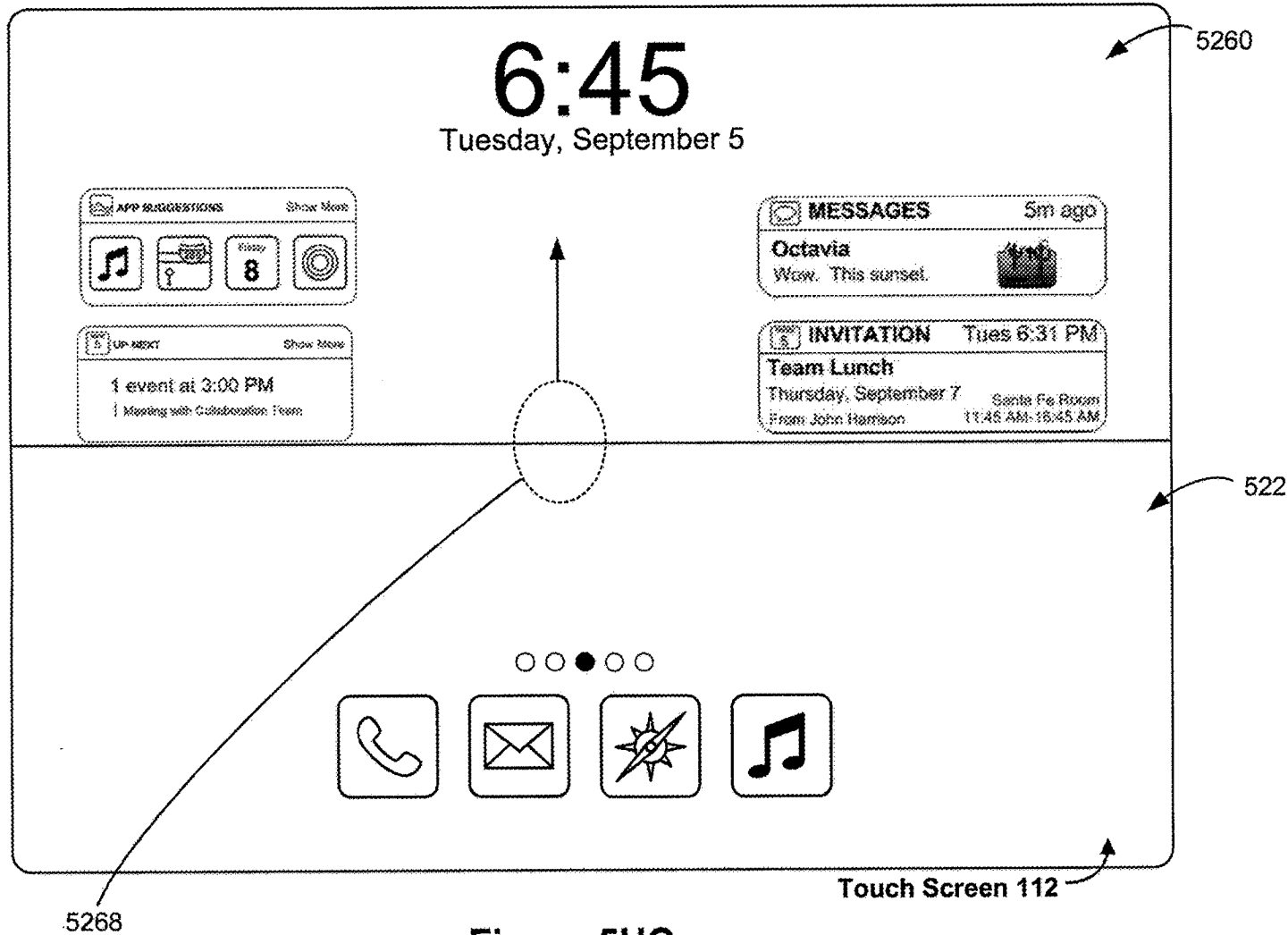


Figure 5HC

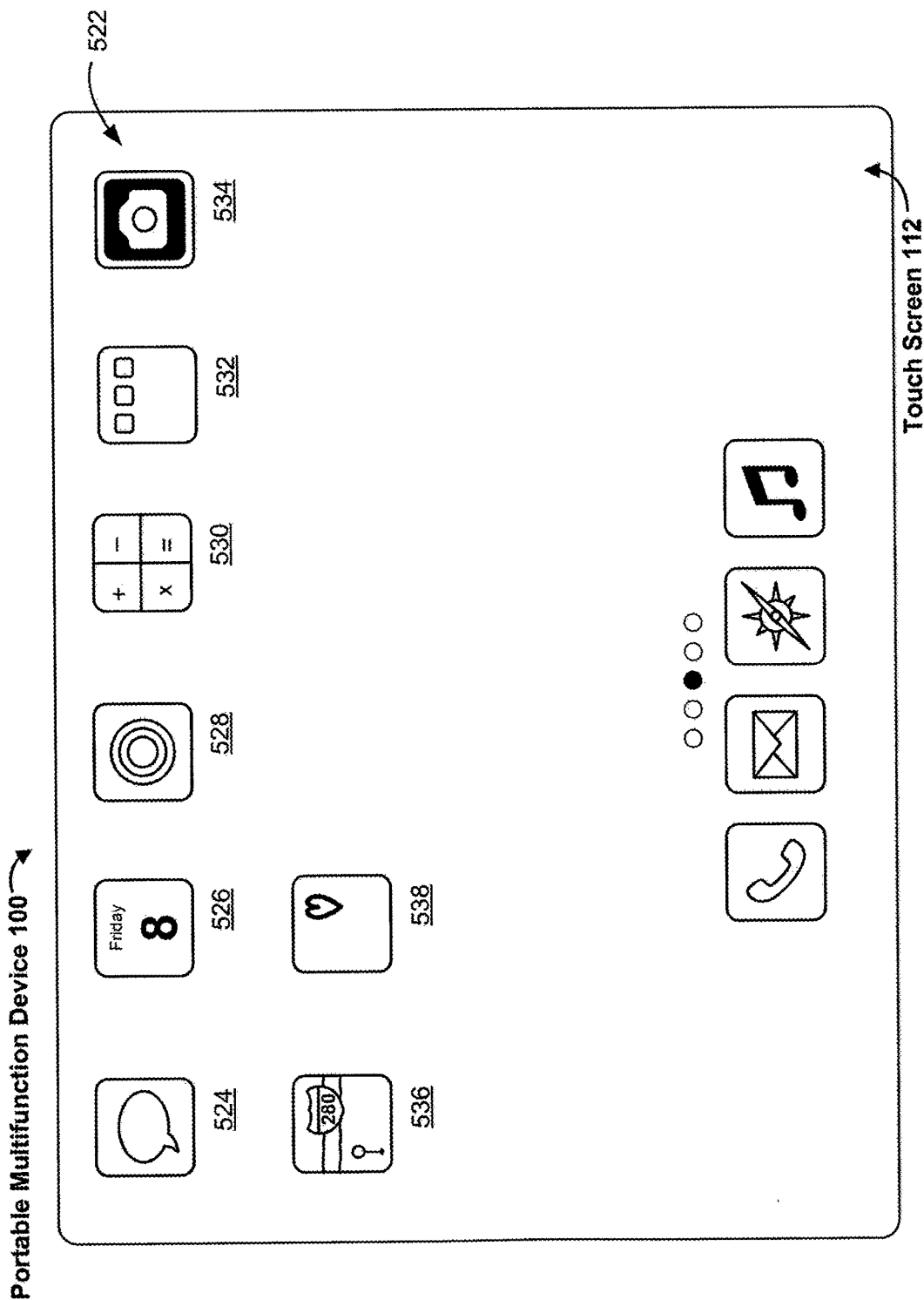


Figure 5HD

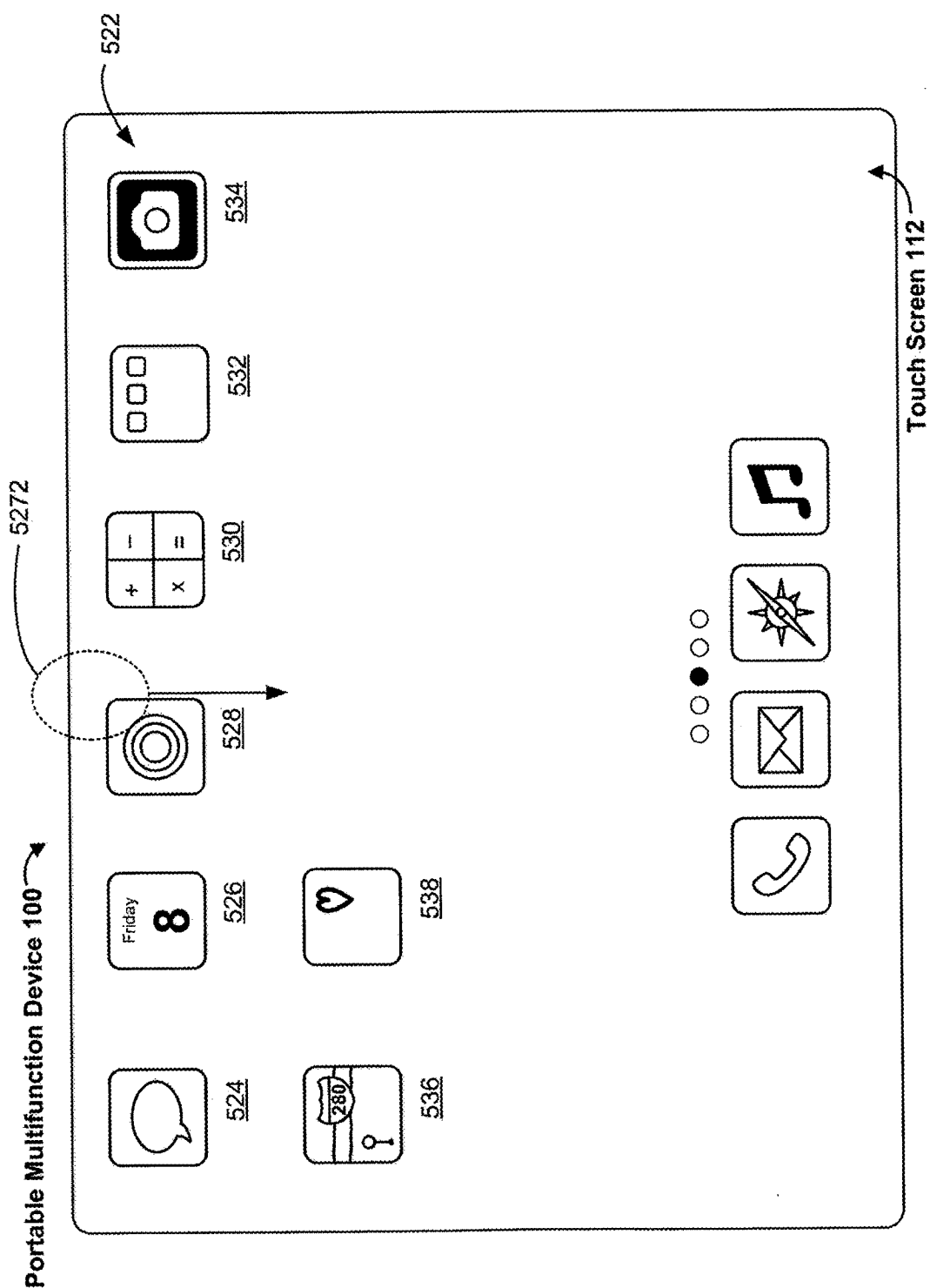


Figure 5HE

Portable Multifunction Device 100

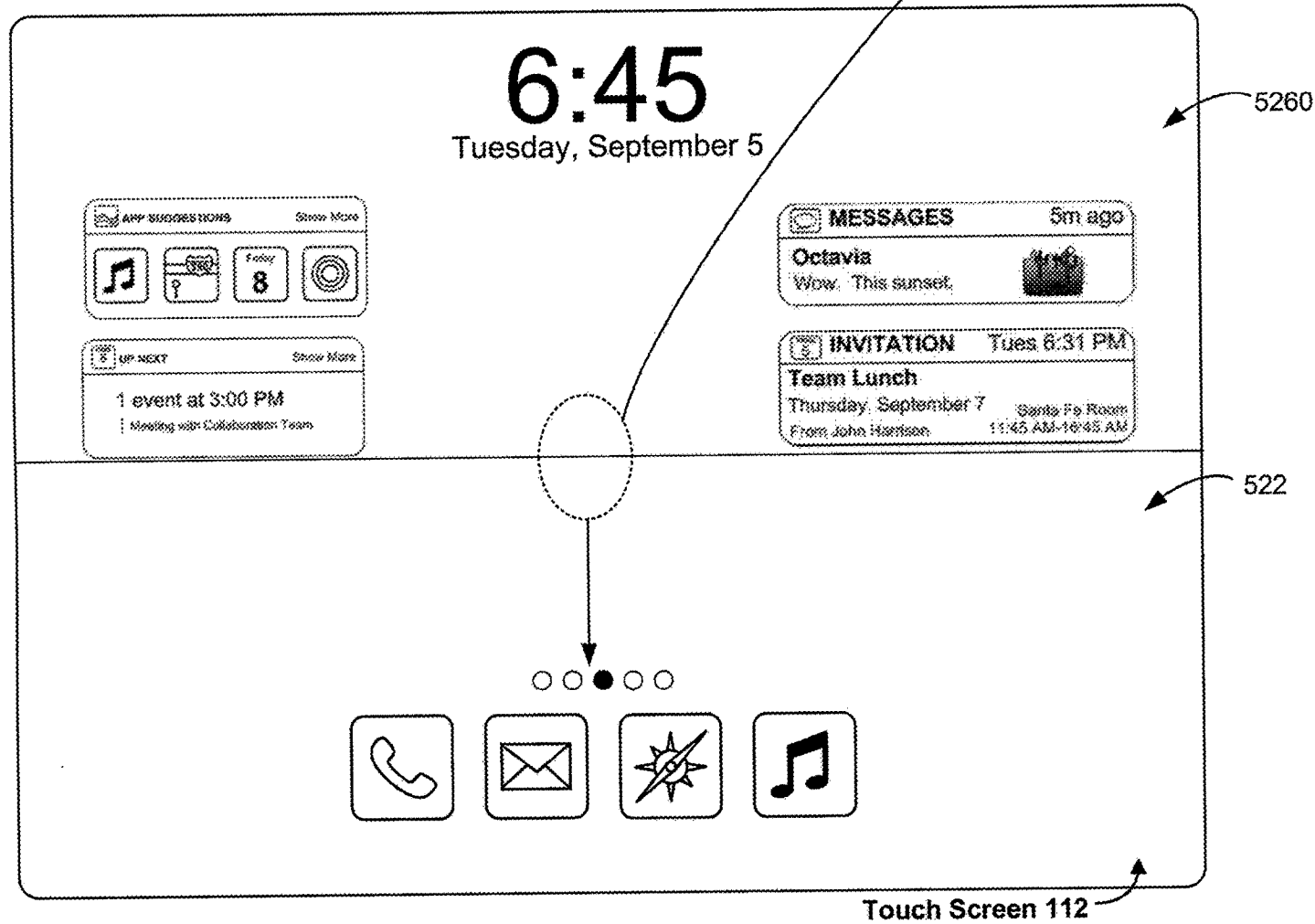


Figure 5HF

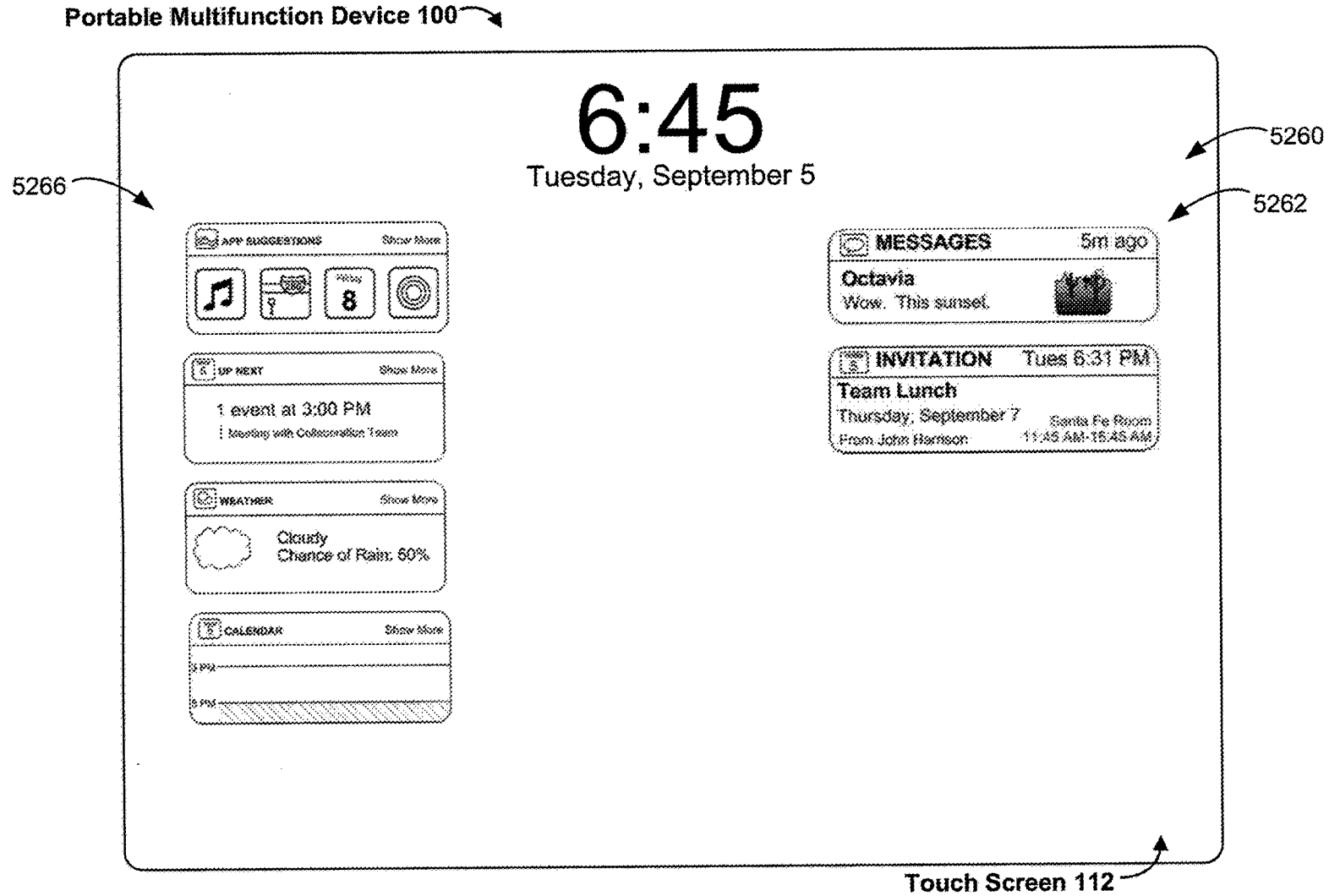


Figure 5HG

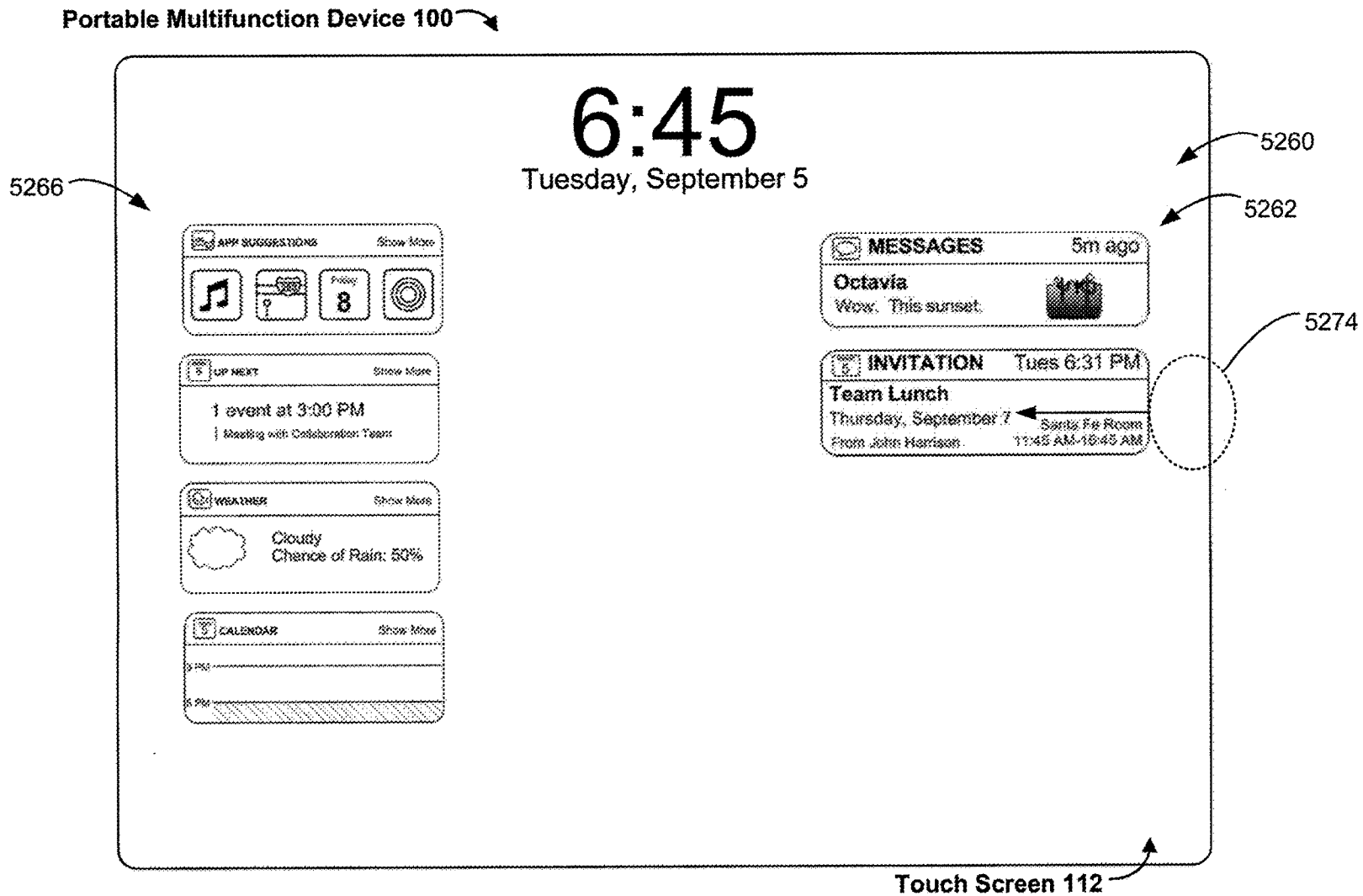


Figure 5HH



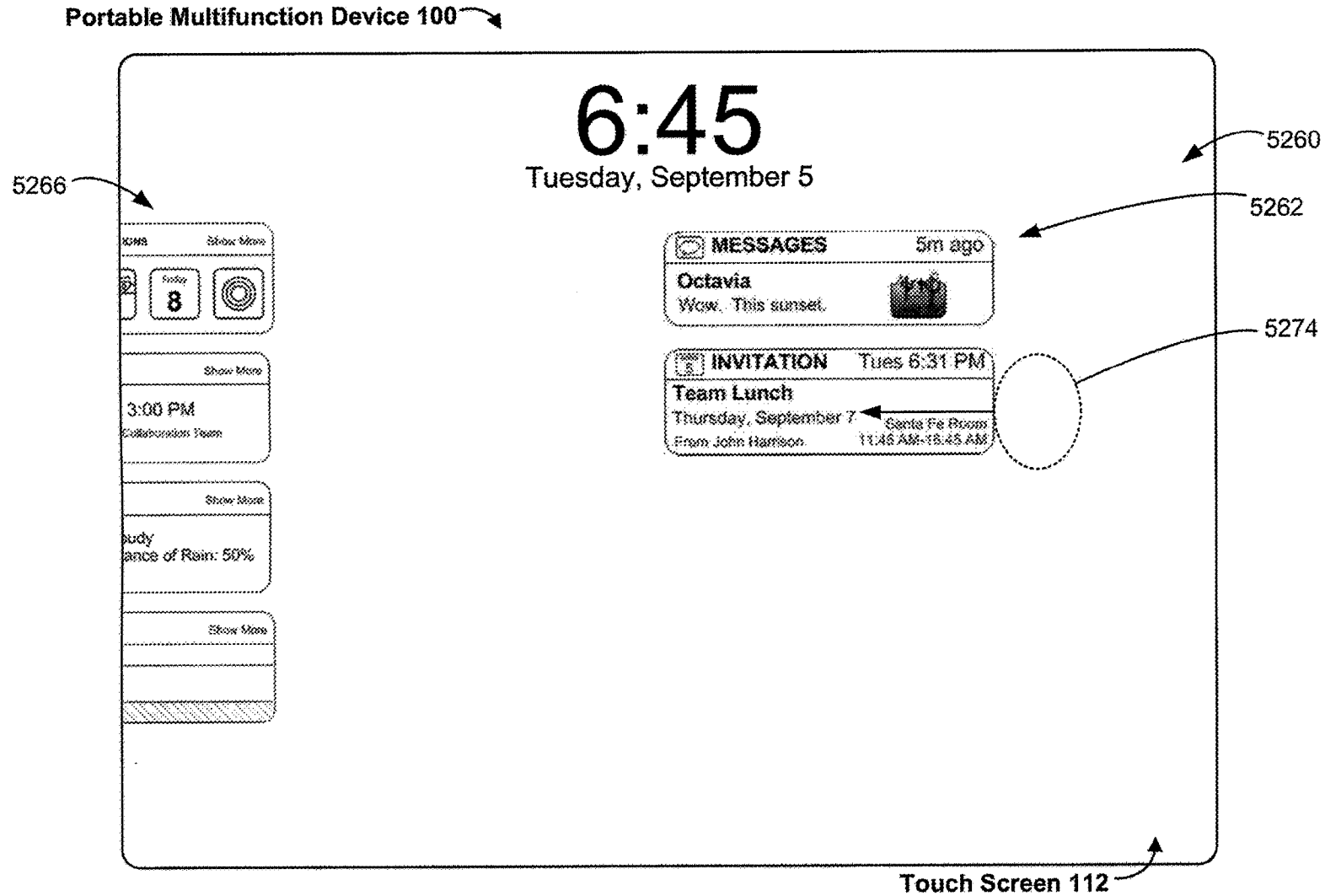


Figure 5H

Portable Multifunction Device 100

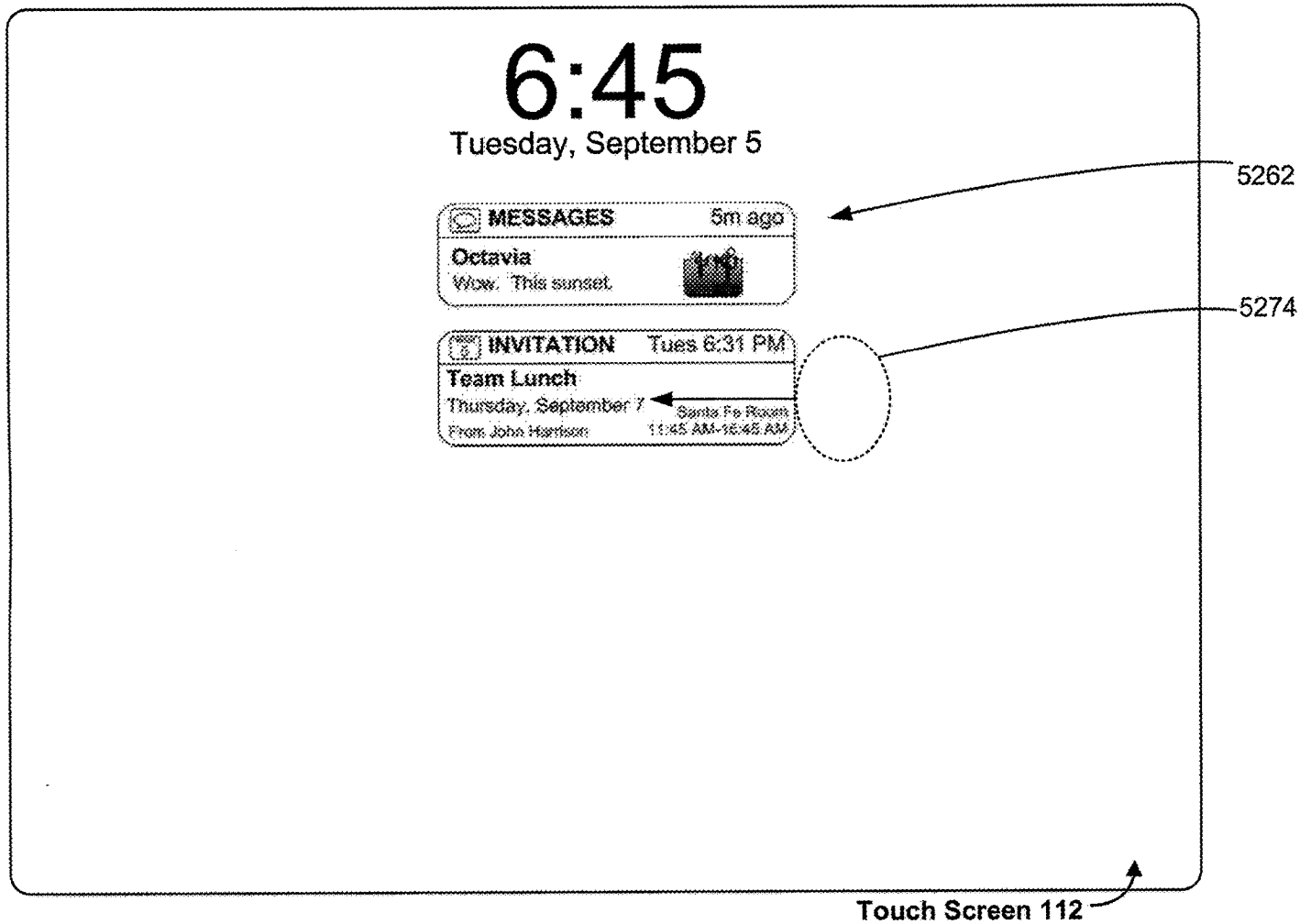


Figure 5HJ

100 Portable Multifunction Device 100

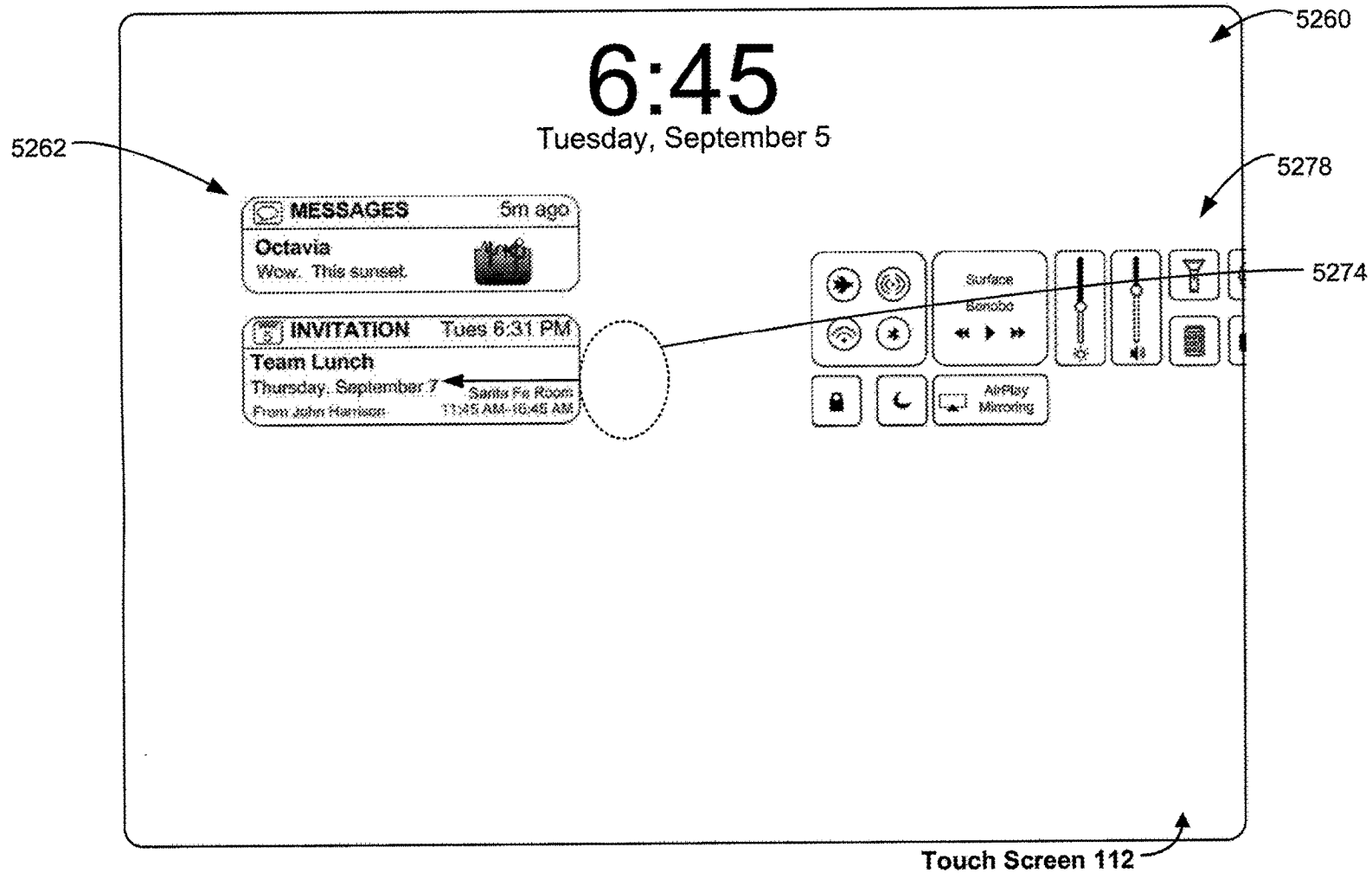


Figure 5HK

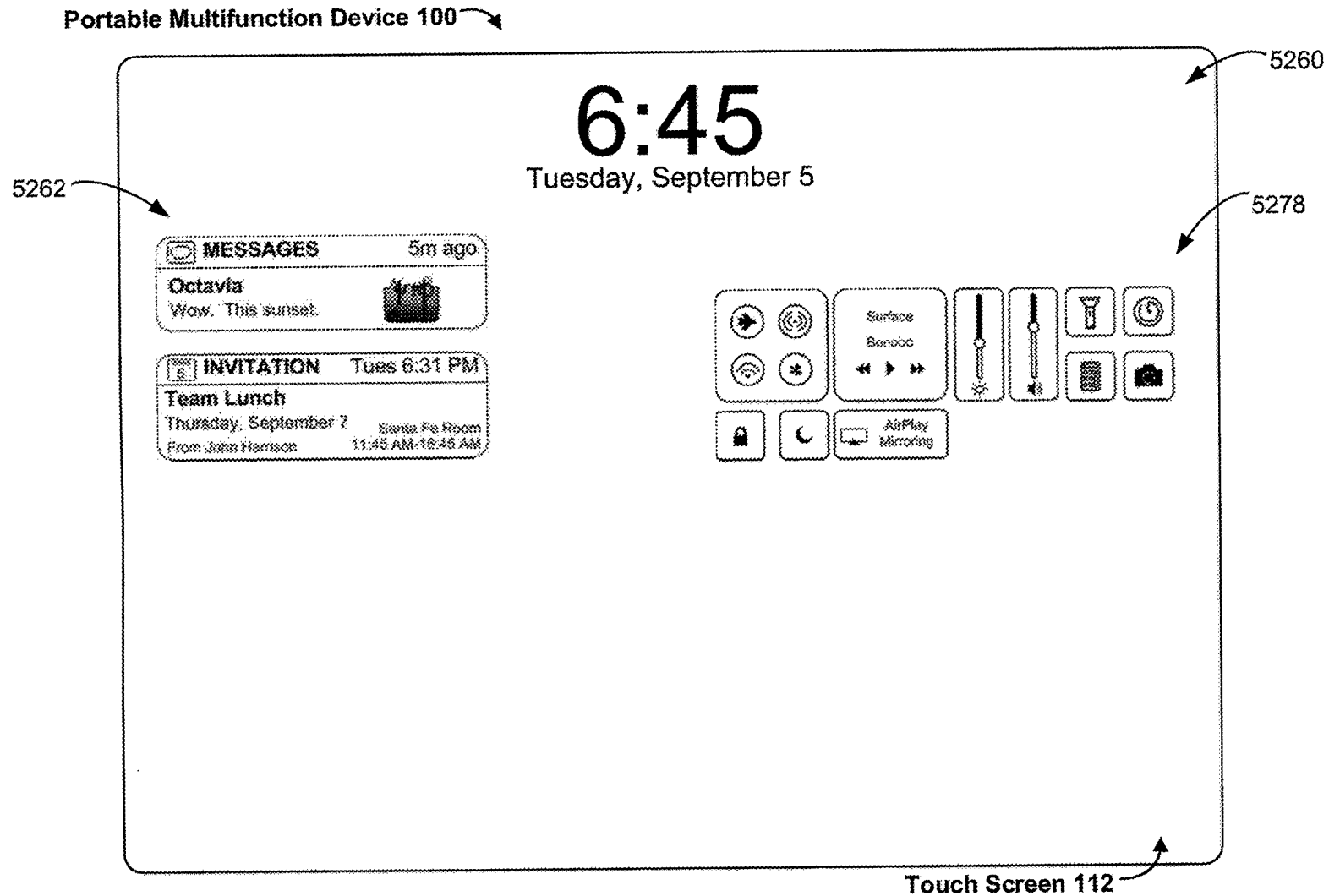


Figure 5HL

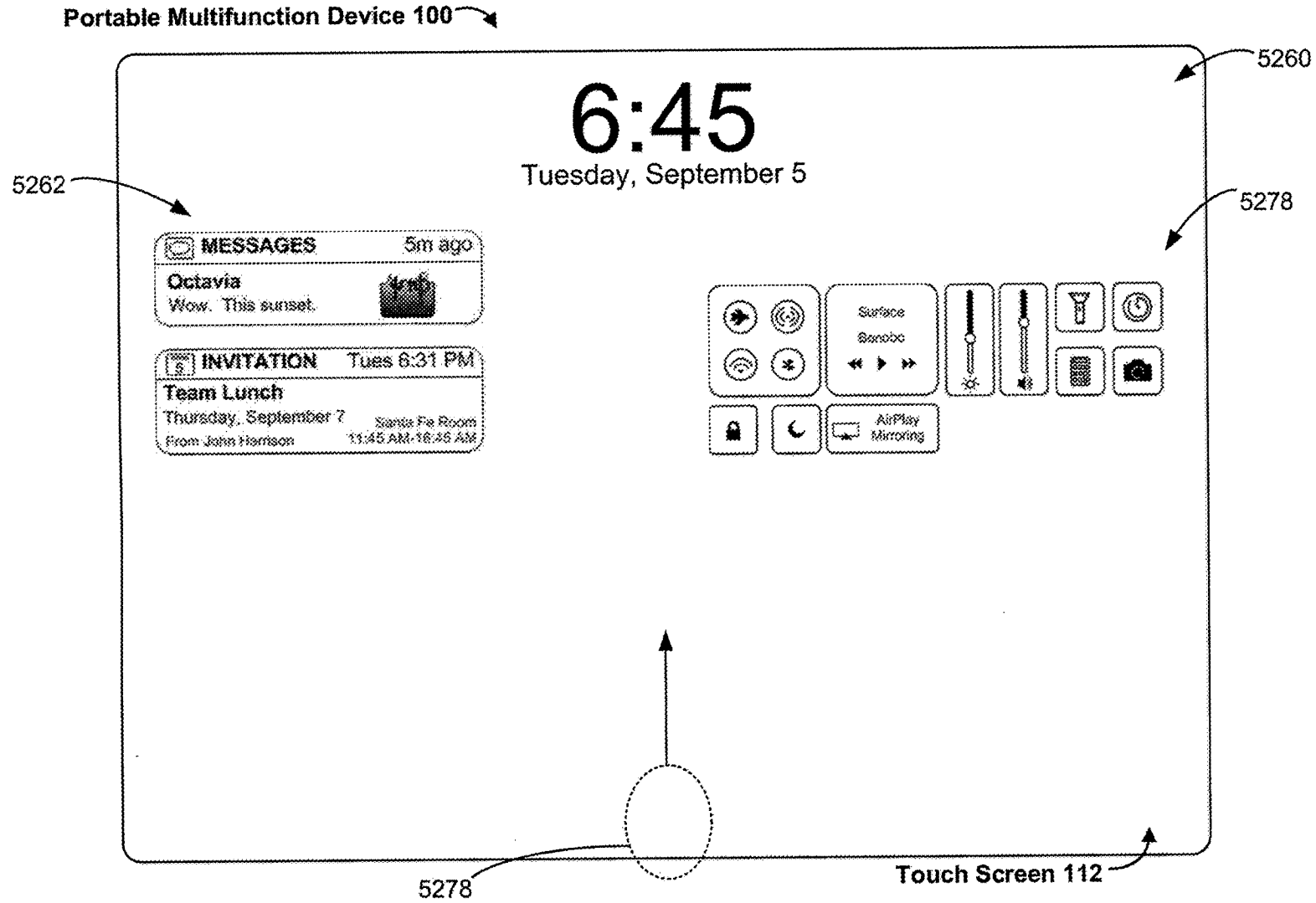


Figure 5HM

Portable Multifunction Device 100

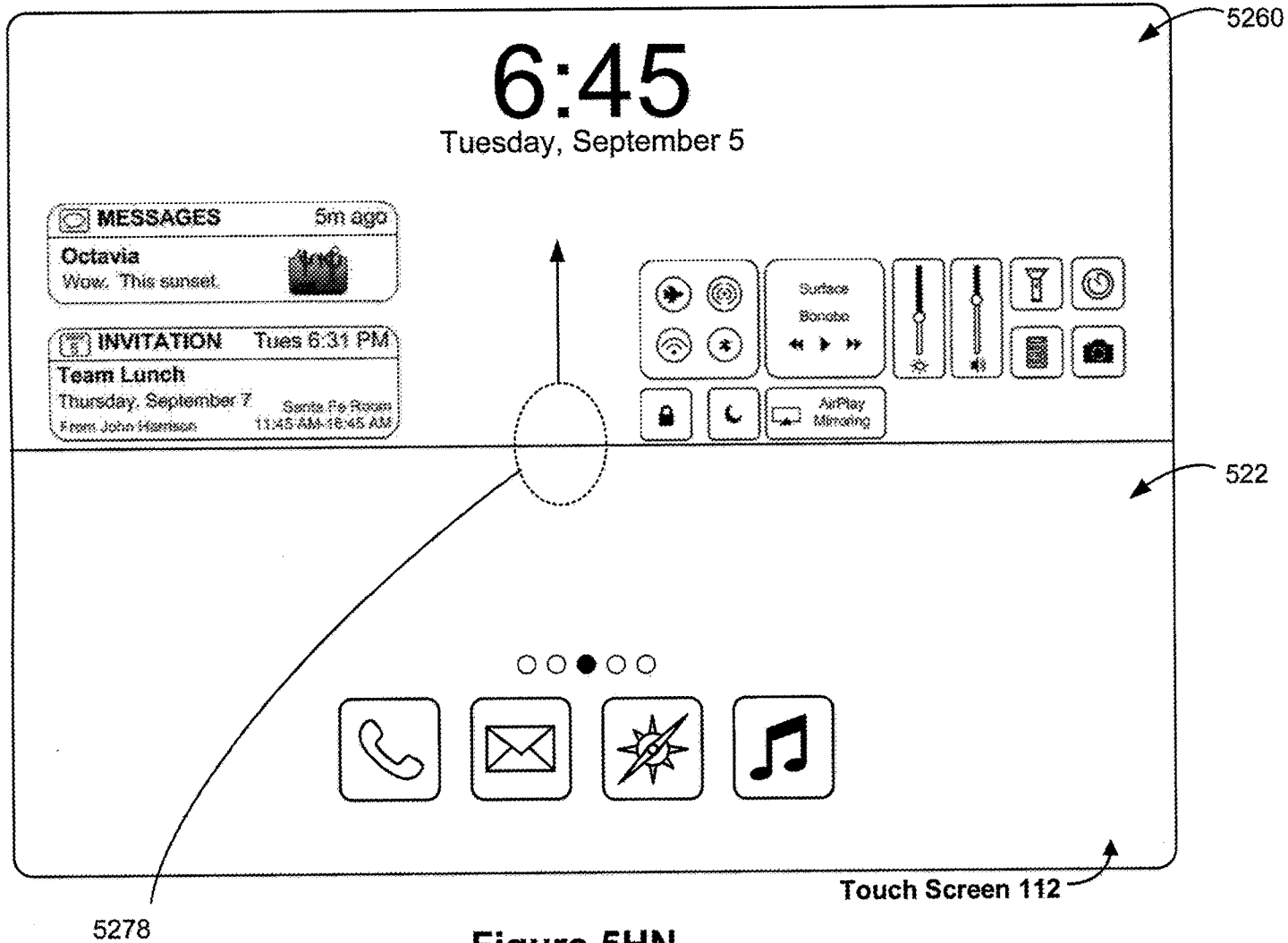


Figure 5HN

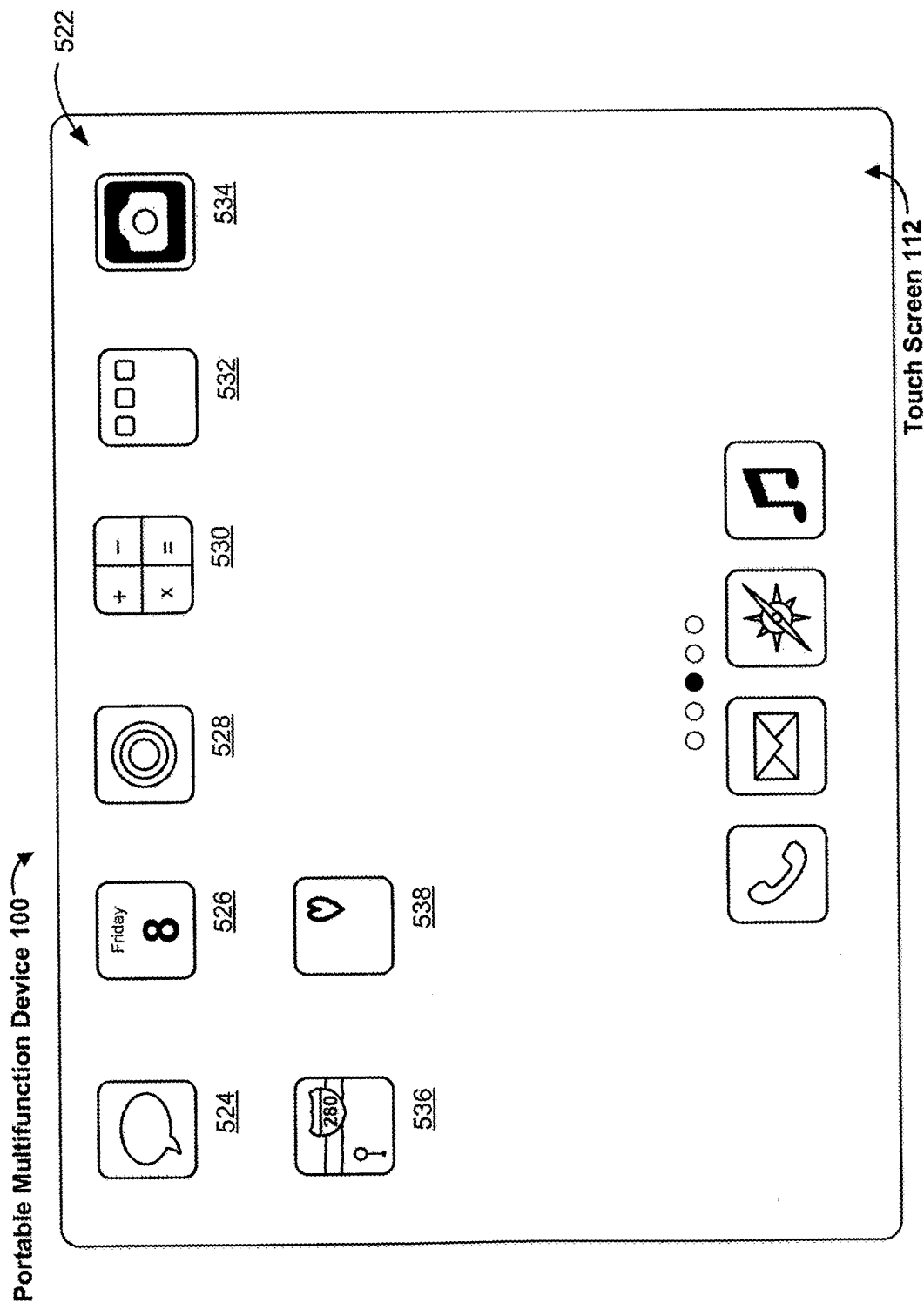


Figure 5HO

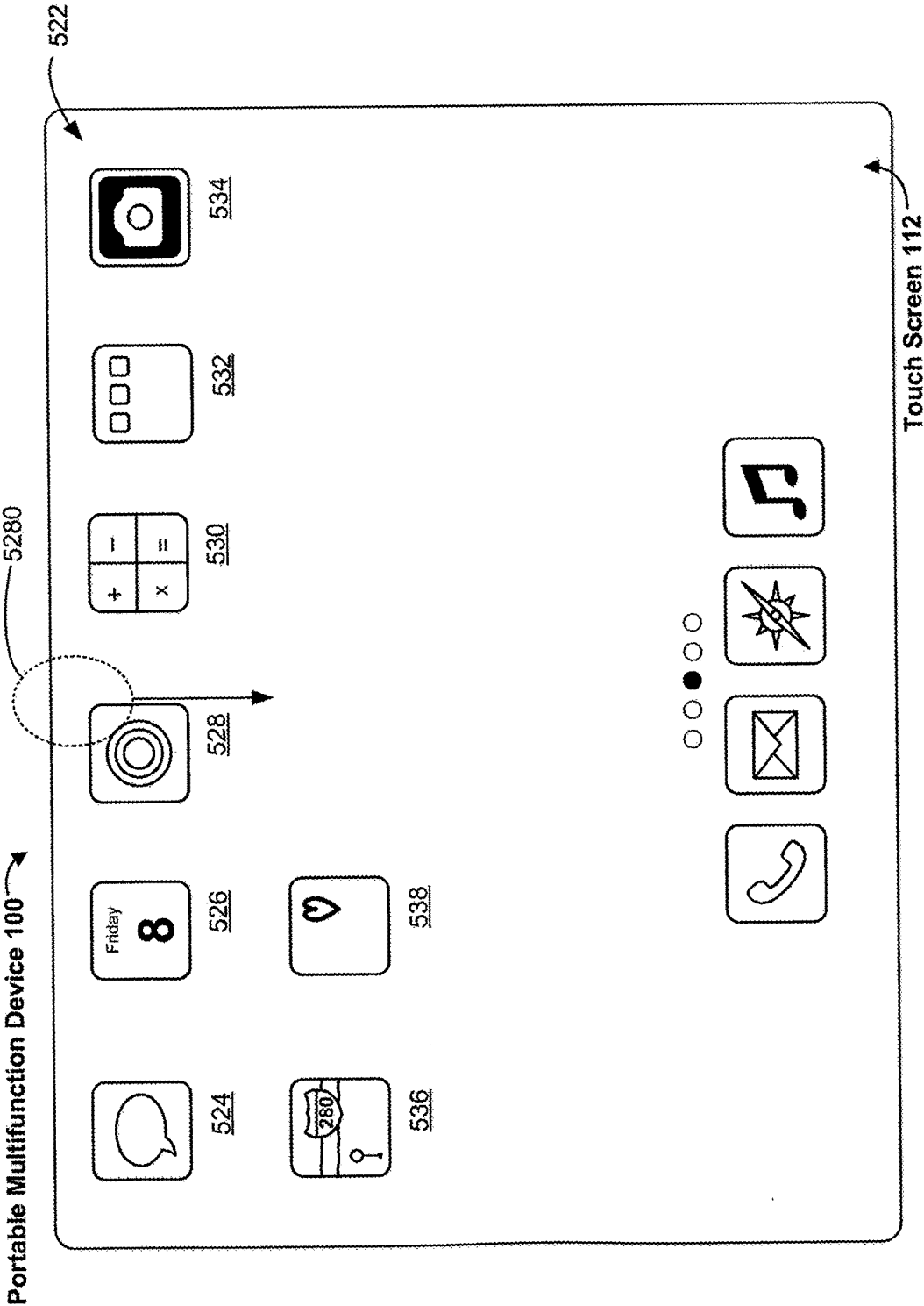
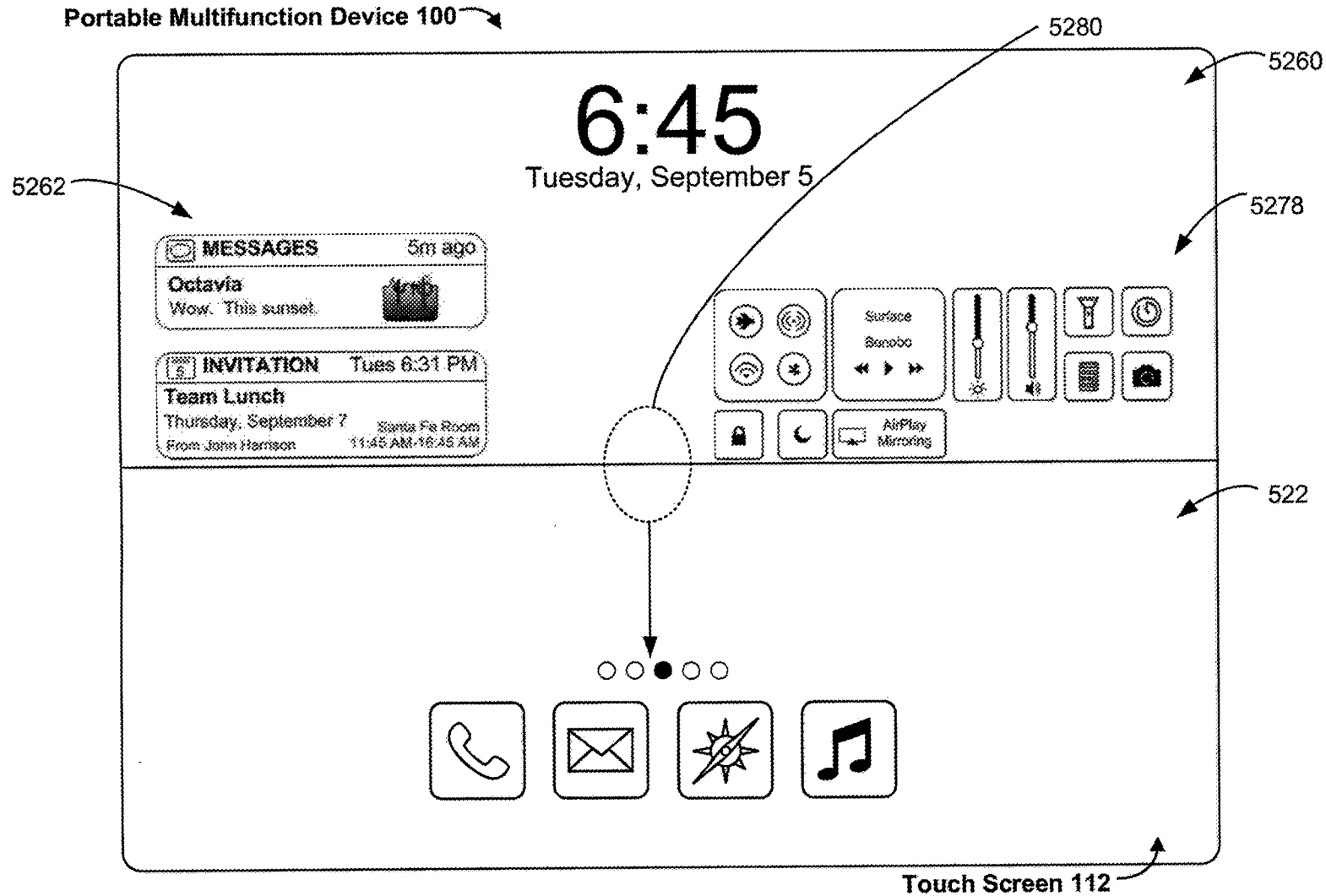


Figure 5HP





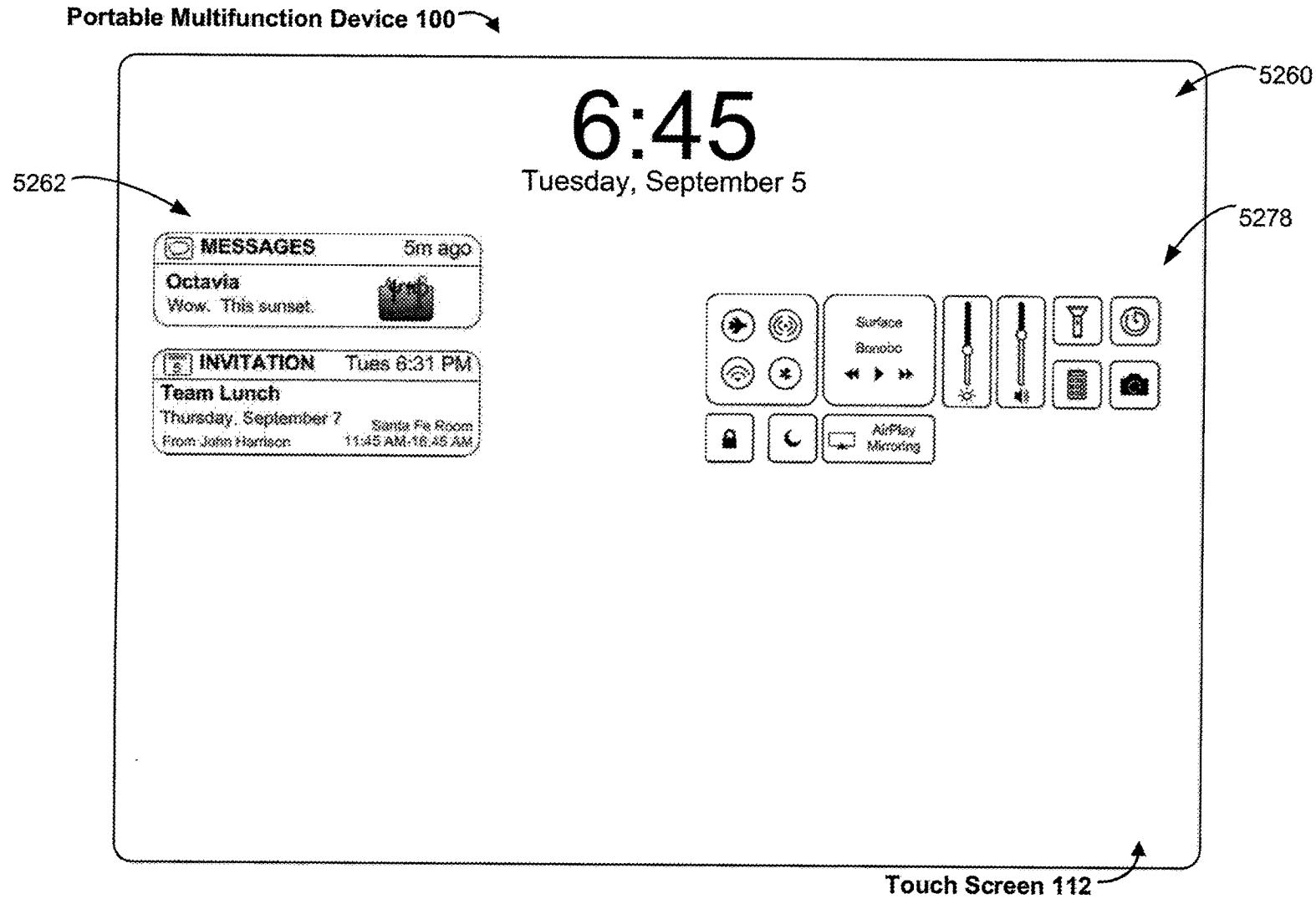


Figure 5HR

U.S. Patent

Aug. 31, 2021

Sheet 236 of 253

US 11,106,352 B2

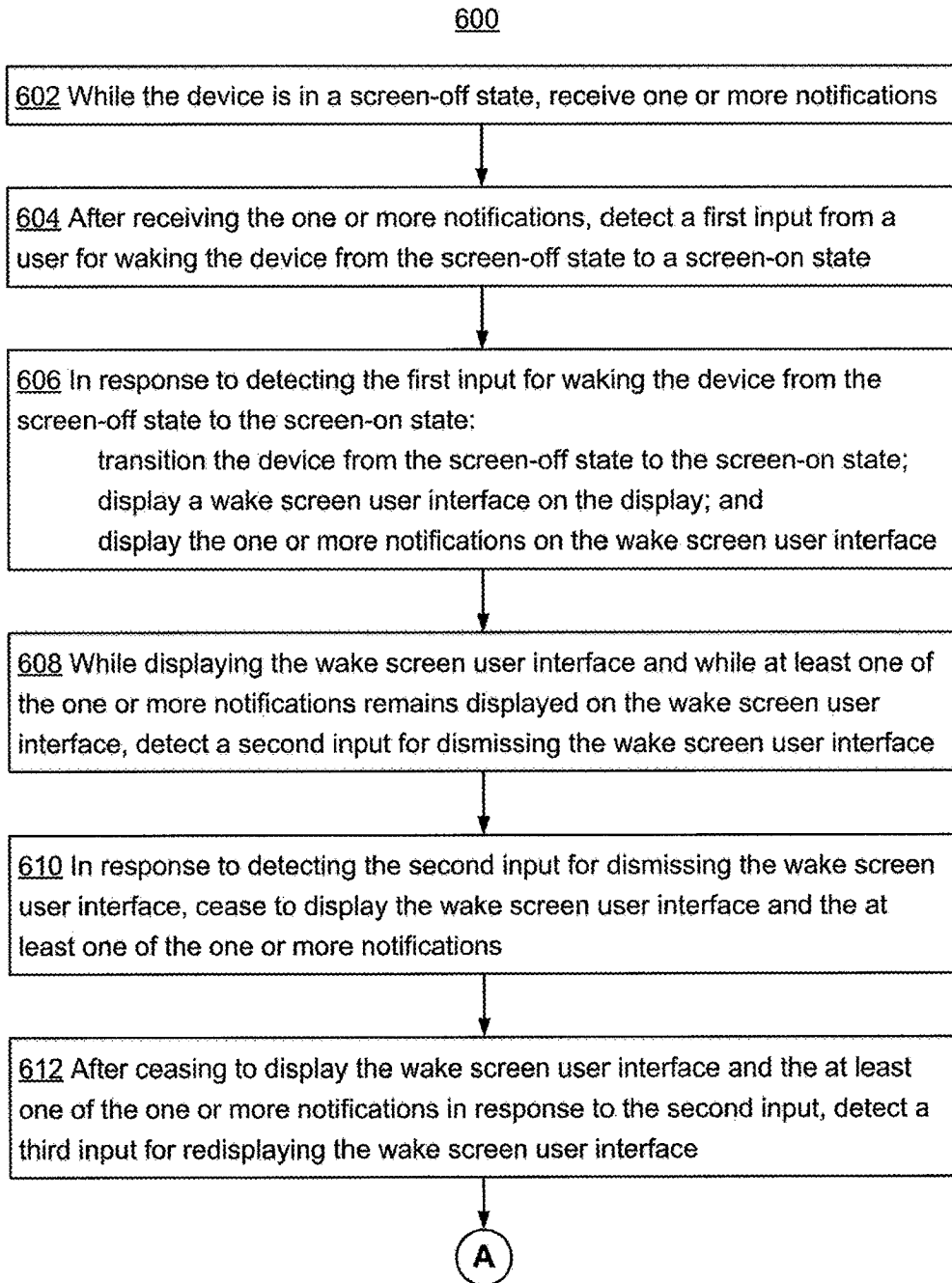


Figure 6A

U.S. Patent

Aug. 31, 2021

Sheet 237 of 253

US 11,106,352 B2

600

A

614 In response to detecting the third input for redisplaying the wake screen user interface:

in accordance with a determination that the third input meets notification-clearance criteria, wherein the notification-clearance criteria require that the third input is detected at a time that is (1) after a respective notification of the one or more notifications has been cleared through direct user interaction with the respective notification or an application that corresponds to the respective notification and (2) after the device has transitioned from the screen-on state to the screen-off state at least once since the detection of the second input, redisplay the wake screen user interface without displaying the at least one of the one or more notifications on the redisplayed wake screen user interface; and

in accordance with a determination that the third input does not meet the notification-clearance criteria:

redisplay the wake screen user interface, and

redisplay the at least one of the one or more notifications on the redisplayed wake screen user interface

616 In response to detecting the third input for redisplaying the wake screen user interface, and in accordance with the determination that the third input does not meet the notification-clearance criteria:

in accordance with a determination that one or more notification-clearance interactions have occurred, forgo display of one or more notifications that are cleared by the one or more notification-clearance interactions on the redisplayed wake screen user interface

B

Figure 6B

600

B

618 After detecting the first input for waking the device from the screen-off state to the screen-on state and prior to detecting the second input for dismissing the wake screen user interface:

detect a plurality of intermediate inputs, the plurality of intermediate inputs including:

a first intermediate input for dismissing the wake screen user interface, and

a second intermediate input for redisplaying the wake screen user interface

620 The second input for dismissing the wake screen user interface is an input for displaying a first user interface that is distinct from the wake screen user interface,

the first user interface is displayed in response to the second input, and

the third input for redisplaying the wake screen user interface was received while the first user interface is displayed

622 The third input for redisplaying the wake screen user interface is received while a content playback application is active, and  
redisplaying the wake screen user interface includes displaying at least one media playback control in the wake screen user interface

624 While the wake screen user interface is displayed, detect a fourth input by a contact on the touch-sensitive surface, including detecting movement of the contact along the touch-sensitive surface in a first direction and detecting lift-off of the contact after the movement; and

in response to detecting the fourth input:

moving at least one object displayed on the wake screen user interface in accordance with the movement of the contact; and,

reversing the movement of the at least one object upon lift-off of the contact

C

Figure 6C

U.S. Patent

Aug. 31, 2021

Sheet 239 of 253

US 11,106,352 B2

600

C

626 While displaying the one or more notifications on the wake screen user interface, detect a fifth input by a contact on the touch-sensitive surface at a location that corresponds to a first notification of the one or more notifications; and,  
in response to detecting the fifth input:  
                cease to display the wake screen user interface; and  
                display a first application user interface for a first application that corresponds to the first notification

628 While displaying the first application user interface for the first application that corresponds to the first notification, detect a sixth input for redisplaying the wake screen user interface;  
in response to detecting the sixth input for redisplaying the wake screen user interface:  
                cease to display the first application user interface,  
                display the wake screen user interface,  
                display at least one second notification of the one or more notifications on the wake screen user interface, wherein the at least one second notification corresponds to a second application that is distinct from the first application, and  
                forgo display of the first notification on the wake screen user interface with the at least one second notification

630 After detecting the sixth input, while displaying the wake screen user interface, detect a seventh input for dismissing the wake screen user interface; and  
in response to detecting the seventh input for dismissing the wake screen user interface:  
                cease to display the wake screen user interface, and  
                redisplay the first application user interface for the first application

D

Figure 6D

U.S. Patent

Aug. 31, 2021

Sheet 240 of 253

US 11,106,352 B2

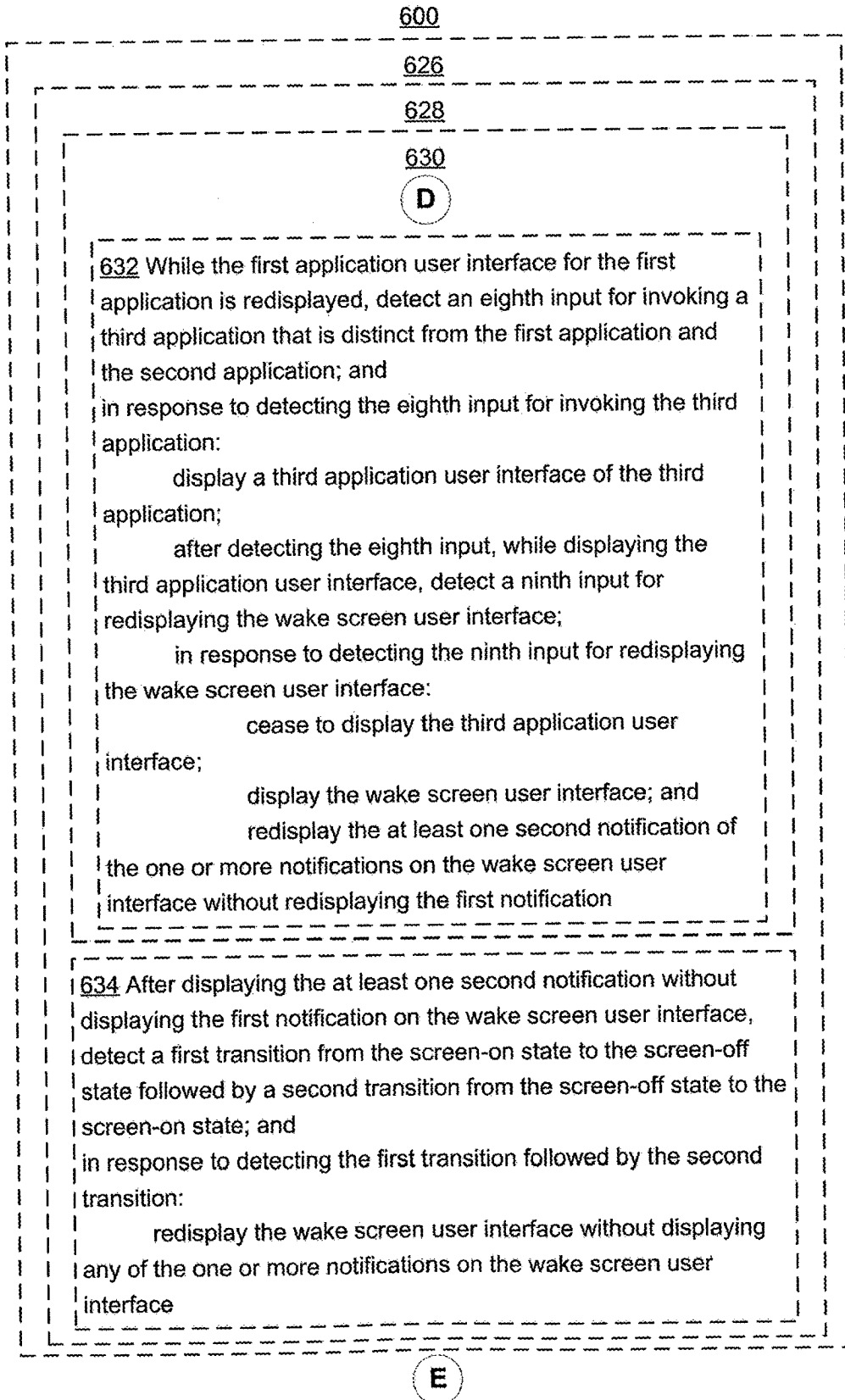


Figure 6E



U.S. Patent

Aug. 31, 2021

Sheet 241 of 253

US 11,106,352 B2

600

E

636 While displaying the wake screen user interface with all of the one or more notifications, detect a third transitioning from the screen-on state to the screen-off state followed by a fourth transition from the screen-off state to the screen-on state; and  
in response to detecting the third transition followed by the fourth transition:  
    redisplay the wake screen user interface with the one or more notifications on the wake screen user interface

638 While displaying the wake screen user interface with the one or more notifications, detect a tenth input for displaying an authentication user interface;  
in response to detecting the tenth input for displaying the authentication user interface:  
    cease to display the wake screen user interface; and  
    display the authentication user interface;  
    while the authentication user interface is displayed, detect an authorization input;  
    in accordance with a determination that the authorization input is valid, display a second user interface;  
    while displaying the second user interface, detect an eleventh input for redisplaying the wake screen user interface; and,  
    in response to detecting the eleventh input:  
        cease to display the second application user interface; and  
        redisplay the wake screen user interface with the one or more notifications

640 In accordance with the determination that the third input meets the notification-clearance criteria, add, to a set of recent notifications, one or more cleared notifications that correspond to the at least one of the one or more not displayed on the wake screen user interface

F

Figure 6F



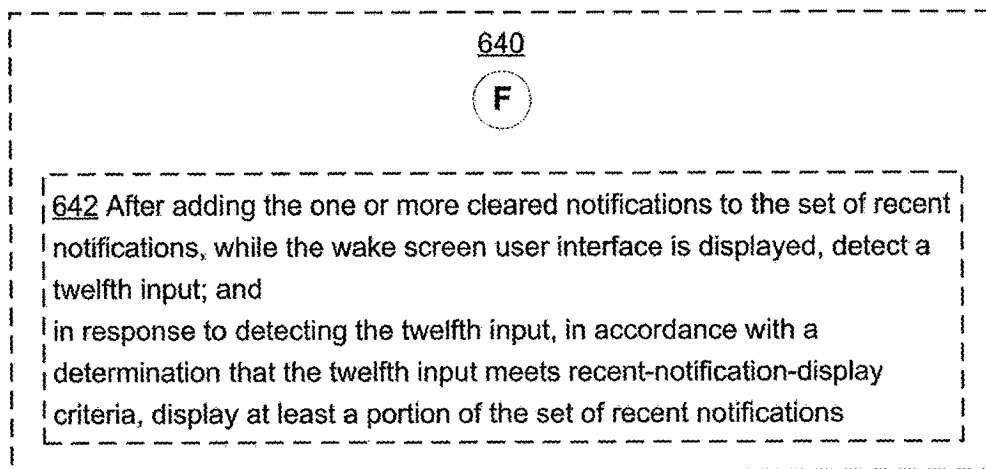
**U.S. Patent**

**Aug. 31, 2021**

**Sheet 242 of 253**

**US 11,106,352 B2**

600



**Figure 6G**

U.S. Patent

Aug. 31, 2021

Sheet 243 of 253

US 11,106,352 B2

700

702 Display a first user interface, including displaying one or more missed notifications in a first scrollable arrangement on the first user interface

704 While displaying the first user interface with the one or more missed notifications, detect a first swipe gesture, including detecting a first contact at a location on the touch-sensitive surface that corresponds to the first scrollable arrangement, and detecting first movement of the first contact across the touch-sensitive surface in a first direction

706 In response to detecting the first swipe gesture, scroll the first scrollable arrangement in accordance with the first movement of the first contact

708 After scrolling the first scrollable arrangement in accordance with the first movement of the first contact, detect a second swipe gesture, including detecting a second contact at a location on the touch-sensitive surface that corresponds to the first scrollable arrangement, and detecting second movement of the second contact across the touch-sensitive surface in the first direction

710 In response to detecting the second swipe gesture:  
in accordance with a determination that the second movement of the second contact meets notification-history-display criteria, wherein the notification-history-display criteria require (1) that the second movement of the second contact is detected after an end of the first scrollable arrangement has been reached in accordance with the first movement of the first contact and (2) that the second movement exceeds a first threshold amount of movement in the first direction, display a plurality of previously received notifications that are distinct from the one or more missed notifications in a second scrollable arrangement on the first user interface; and,  
in accordance with the determination that the second movement of the first contact does not meet the notification-history-display criteria, forgo displaying the plurality of previously received notifications

A

Figure 7A

**U.S. Patent**

**Aug. 31, 2021**

**Sheet 244 of 253**

**US 11,106,352 B2**

700

**A**

712 The first user interface is a wake screen user interface, and the first user interface is displayed immediately upon waking the device from the display-off state to the display-on state

714 While displaying the one or more missed notifications in the first scrollable arrangement on the first user interface, detect a missed notification dismissal input for dismissing a respective notification of the one or more missed notifications in the first scrollable arrangement;  
after detecting the missed notification dismissal input for dismissing the respective notification:

    cease to display the respective notification of the one or more notifications on the first user interface, and  
    add the respective notification to the plurality of previously received notifications

716 While the first user interface is displayed, detect a third swipe gesture, including detecting a third contact at a location on the touch-sensitive surface that corresponds the first scrollable arrangement and detecting third movement of the third contact across the touch-sensitive surface in a second direction that is distinct from the first direction;  
in response to detecting the third swipe gesture, translate the first scrollable arrangement in accordance with the third movement of the third contact;  
detect lift-off of the third contact from the touch-sensitive surface after detecting the third movement; and,  
in response to detecting the liftoff of the third contact, reverse the translation of the first scrollable arrangement that was made in accordance with the third movement of the third contact

**B**

**Figure 7B**

U.S. Patent

Aug. 31, 2021

Sheet 245 of 253

US 11,106,352 B2

700

**B**

718 While displaying the plurality of previously received notifications in the second scrollable arrangement on the first user interface, detect a fourth swipe gesture, including detecting a fourth contact at a location on the touch-sensitive surface that corresponds to the second scrollable arrangement and detecting fourth movement of the fourth contact across the touch-sensitive surface in a second direction opposite the first direction; and, in response to detecting the fourth swipe gesture:

in accordance with a determination that the fourth movement of the fourth contact meets notification-history-dismissal criteria, wherein the notification-history-dismissal criteria require (1) that the fourth movement of the fourth contact is detected after an end of the second scrollable arrangement has been reached and (2) that the fourth movement exceeds a second threshold amount of movement in the second direction opposite the first direction, cease to display the plurality of previously received notifications on the first user interface; and,

in accordance with the determination that the fourth movement of the fourth contact does not meet the notification-history-dismissal criteria, scroll the plurality of previously received notifications in the second scrollable arrangement in accordance with the fourth movement of the fourth contact

720 While displaying the first user interface, detect a first user interface dismissal input for input for dismissing the first user interface; and, in response to detecting the first user interface dismissal input, cease to display the first user interface

722 The device includes one or more tactile output generators, and the method includes:

while the first user interface is displayed, in accordance with the determination that the second movement of the second contact meets the notification-history-display criteria, generating, with the one or more tactile output generators, a tactile output to indicate that the criteria for displaying the plurality of previously received notifications have been met

**C**

**Figure 7C**

U.S. Patent

Aug. 31, 2021

Sheet 246 of 253

US 11,106,352 B2

700

C

724 The first contact moves with a first rate of movement during the first swipe gesture;  
scrolling the first scrollable arrangement occurs at a first scroll rate that corresponds to the first rate of movement by the first contact;  
the second contact moves with a second rate of movement during the second swipe gesture; and  
displaying the plurality of previously received notifications in the second scrollable arrangement includes scrolling a first previously received notification of the plurality of previously received notifications in the second scrollable arrangement at a second scroll rate that is greater than the second rate of movement by the second contact

726 Detect a fifth swipe gesture, including detecting a fifth contact at a first location on the touch-sensitive surface and detecting fifth movement of the fifth contact across the touch-sensitive surface in a third direction that is perpendicular to the first direction;  
in response to detecting the fifth swipe gesture:  
in accordance with a determination that the first location on the touch-sensitive surface corresponds to a first notification among the one or more missed notifications or the plurality of previously received notifications, dismiss the first notification; and  
in accordance with a determination that the first location on the touch-sensitive surface corresponds to a location outside of the first scrollable arrangement and the second scrollable arrangement:  
replace display of the first user interface with display of a second user interface

D

Figure 7D

U.S. Patent

Aug. 31, 2021

Sheet 247 of 253

US 11,106,352 B2

700

D

728 Detect that criteria for dismissing all of the one or more missed notifications in the first scrollable arrangement are met; and  
in response to detecting that the criteria for dismissing all of the one or more missed notifications are met:  
add, to the plurality of previously received notifications, all of the one or more missed notifications

730 While displaying the first user interface without any missed notifications, detect a sixth swipe gesture, including a sixth contact at a location on the touch-sensitive surface that corresponds to the location at which the first scrollable arrangement was previously displayed, and detecting sixth movement of the sixth contact across the touch-sensitive surface in the first direction;  
in response to detecting the sixth swipe gesture:  
in accordance with a determination that the sixth movement of the sixth contact exceeds the first threshold amount of movement in the first direction, display the plurality of previously received notifications; and  
in accordance with the determination that the sixth movement of the sixth contact does not exceed the first threshold amount of movement in the first direction, forgo displaying the plurality of previously received notifications

732 While the first user interface is displayed without any missed notifications, detect a seventh swipe gesture, including detecting a seventh contact at a location on the touch-sensitive surface that corresponds to the location at which the first scrollable arrangement was previously displayed, detecting seventh movement of the seventh contact across the touch-sensitive surface in a second direction opposite the first direction; in response to detecting the seventh swipe gesture, translating at least one object displayed on the first user interface in the second direction in accordance with the seventh movement of the seventh contact;  
after translating the at least one object, detect lift-off of the seventh contact;  
and  
in response to detecting liftoff of the seventh contact from the touch-sensitive surface, reverse the translation of the at least one object that have been made in accordance with the seventh movement of the seventh contact

Figure 7E

U.S. Patent

Aug. 31, 2021

Sheet 248 of 253

US 11,106,352 B2

800

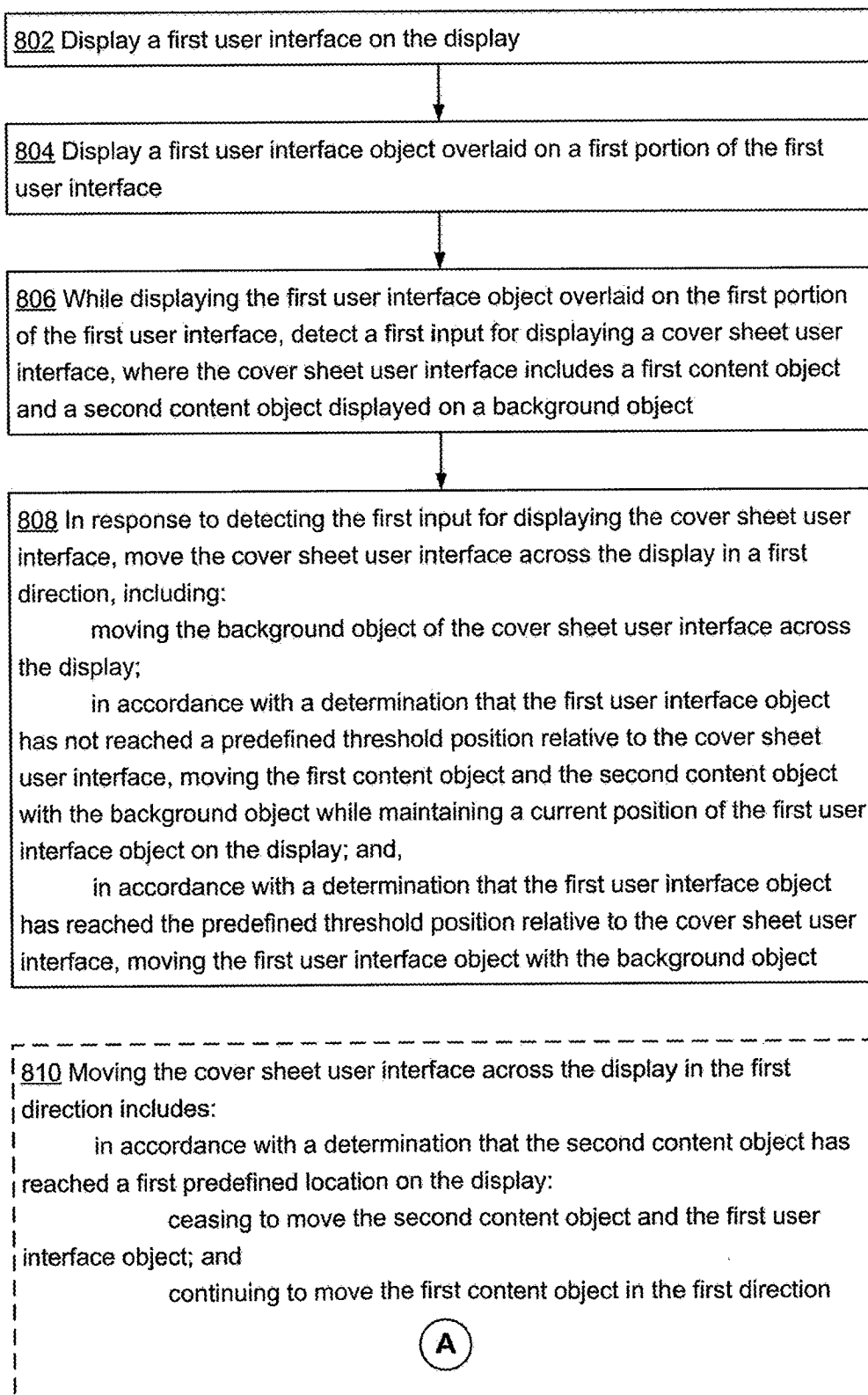


Figure 8A



**U.S. Patent**

**Aug. 31, 2021**

**Sheet 249 of 253**

**US 11,106,352 B2**

800

810

**A**

812 Cease to continue to move the first content object in the first direction in accordance with a determination that the first content object has reached a second predefined location on the display

814 Transition the device from a screen-on state to a screen-off state in accordance with a determination that display shutoff criteria are met; and, while the display is in the screen-off state, display the first user interface object on a dark screen corresponding to the screen-off state

816 While the display is in the screen-off state and the first user interface object is displayed on the display:  
receive one or more notifications; and,  
in response to receiving the one or more notifications,  
display the first user interface object and a third content object on the first user interface

818 Transition the device from a screen-off state to a screen-on state in accordance with a determination that display-waking criteria are met; and in response to transitioning the device from the screen-off state to the screen-on state, display the first user interface object on a dark screen that corresponds to the display-off state

820 While the cover sheet interface is displayed, detect a third input for dismissing the cover sheet user interface, wherein the third input includes a swipe gesture by a contact on the touch-sensitive surface; and in response to detecting the third input for dismissing the cover sheet user interface:  
cease to display the cover sheet user interface;  
maintain display of the first user interface object; and  
display a home screen user interface, wherein the first user interface object is overlaid on the home screen user interface

**B**

**Figure 8B**



U.S. Patent

Aug. 31, 2021

Sheet 250 of 253

US 11,106,352 B2

800

B

820

822 While displaying the first user interface object overlaid on the home screen user interface, detect an input for minimizing the first user interface object;

in response to detecting the input for minimizing the first user interface object:

transition the first user interface object into a second user interface object, wherein the first user interface object has a first size and the second user interface object has a second size that is smaller than the first size

824 While the second user interface object is displayed, determine that the display shutoff criteria are met; and

in response to determining that the display shutoff criteria are met:

transition the device from the screen-on state to a screen-off state;

transition the second user interface object into the first user interface object; and

display the first user interface object overlaid a dark screen corresponding to the screen-off state

826 While the second user interface object is displayed, detect an input for activating the second user interface object; and

in response to detecting the input for activating the second user interface object, display an application user interface of an application that corresponds to the second user interface object

828 While the first user interface object is displayed, detect an input that activates the first user interface object; and

in response to detecting the input that activates the first user interface object, display the application user interface of the application that corresponds to the information displayed in the first user interface object

Figure 8C

U.S. Patent

Aug. 31, 2021

Sheet 251 of 253

US 11,106,352 B2

900

902 While the device is in a screen-off state, detect a first input for waking the device from the screen-off state to a screen-on state; and

904 In response to detecting the first input for waking the device from the screen-off state to the screen-on state:  
transition the device from the screen-off state to the screen-on state, and  
display a wake screen user interface on the display;

906 While displaying the wake screen user interface, detect a first swipe gesture on the touch-sensitive surface, including detecting a first contact on the touch-sensitive surface and detecting movement of the first contact across the touch-sensitive surface;

908 In response to detecting the first swipe gesture:  
cease to display the wake screen user interface; and  
display a first user interface, wherein:  
in accordance with a determination that the first swipe gesture is in a first direction, the displayed first user interface is a mini-application-object user interface, wherein the mini-application-object user interface includes one or more mini-application objects that each provide a subset of functions of a corresponding application without launching the corresponding application; and,  
in accordance with a determination that the first swipe gesture is in a second direction that is opposite the first direction, the displayed first user interface is a control panel user interface, wherein the control panel user interface includes one or more device controls for controlling one or more device functions of the device

A

Figure 9A

U.S. Patent

Aug. 31, 2021

Sheet 252 of 253

US 11,106,352 B2

900

A

910 While the wake screen user interface is displayed, display one or more notifications on the wake screen user interface;  
detect a second input for transitioning the device from an unauthenticated state to an authenticated state; and  
in response to detecting the second input, display, on the wake screen user interface, restricted notification information corresponding to at least one of the one or more notifications

912 While displaying the first user interface in response to the first swipe gesture, detect a second swipe gesture in a third direction that is perpendicular to the first direction and the second direction:  
in accordance with a determination that the device is in an unauthenticated state, display an authentication user interface; and,  
in accordance with a determination that the device is in an authenticated state, display a second user interface, wherein the second user interface is a last displayed user interface that was displayed prior to the display of the wake screen user interface

914 In accordance with a determination that the second user interface is a home screen user interface, display, in the home screen user interface, an object that displays content from a first active application; and,  
in accordance with a determination that a state of the first active application has changed, update the content displayed in the object in accordance with the changed state of the first active application

916 While displaying the second user interface in response to the second swipe gesture, detect a third swipe gesture in a fourth direction that is opposite the third direction; and  
in response to detecting the third swipe gesture in the fourth direction, cease to display the second user interface and redisplay the wake screen user interface

B

Figure 9B

U.S. Patent

Aug. 31, 2021

Sheet 253 of 253

US 11,106,352 B2

900

B

918 The wake screen user interface is displayed with an affordance that displays content from a second active application, the method including:  
while displaying the wake screen user interface with the affordance, in accordance with a determination that a state of the second active application has changed, updating the content displayed in the affordance in accordance with the changed state of the second active application

920 The wake screen user interface includes a first control of the one or more device controls of the control panel user interface

922 The first control requires a first type of input to activate a first function while displayed on the wake screen user interface and the first control requires a second type of input to activate the first function while displayed on the control panel user interface

924 The first control is also displayed on the home screen user interface, and a press input directed to the first control while displayed on the home screen user interface causes display of a plurality of selectable options, and a press input directed to the first control while displayed on the wake screen user interface does not cause display of the plurality of selectable options

926 While displaying the wake screen user interface, display a first object at a first position on the display;  
in accordance with the determination that the first swipe gesture is in the first direction, display the first object on the first user interface at a second position that is shifted in the first direction relative to the first position on the display;  
and,  
in accordance with the determination that the first swipe gesture is in the second direction, display the at least one object at a third position that is shifted in the second direction relative to the first position on the display

Figure 9C

US 11,106,352 B2

1

**DEVICES, METHODS, AND GRAPHICAL  
USER INTERFACES FOR ACCESSING  
NOTIFICATIONS**

**RELATED APPLICATIONS**

This application is a continuation of U.S. application Ser. No. 16/354,012, filed Mar. 14, 2019, which is a continuation of U.S. application Ser. No. 15/715,005, filed Sep. 25, 2017, now U.S. Pat. No. 10,466,889, which claims priority to U.S. Provisional Application No. 62/507,181, filed May 16, 2017, which are hereby incorporated by reference in their entirety.

**TECHNICAL FIELD**

This relates generally to electronic devices with touch-sensitive surfaces, including but not limited to electronic devices with touch-sensitive surfaces that include user interfaces for displaying notifications.

**BACKGROUND**

The use of portable electronic devices has increased significantly in recent years, with many applications typically residing in the memory of such devices. Exemplary applications include messaging applications, calendar applications and social media applications. Electronic devices often receive communications for these applications, which contain information of importance to users. These electronic devices then often provide notifications that correspond to the received communications.

Exemplary communications include instant messages, calendar invitations, social media updates, microblog posts and news stories. Exemplary notifications associated with these communications may include digital images, video, text, icons, control elements (such as buttons) and/or other graphics to notify users of the receipt of these communications. Exemplary applications receiving communications and generating notifications include instant messaging applications (e.g., iMessage from Apple Inc. of Cupertino, Calif.), calendar applications (e.g., iCal or Calendar from Apple Inc. of Cupertino, Calif.), social networking applications, microblogging applications, and news applications.

But user interfaces for accessing notifications, and methods of navigating to and from such interfaces, are cumbersome and inefficient. For example, the notifications may be displayed in a confusing manner, and navigation to and from interfaces that contain notifications may also be confusing. These methods take longer than necessary, thereby wasting energy. This latter consideration is particularly important in battery-operated devices.

**SUMMARY**

Accordingly, there is a need for electronic devices with faster, more efficient methods and interfaces for accessing notifications. Such methods and interfaces optionally complement or replace conventional methods for accessing notifications. Such methods and interfaces reduce the number, extent, and/or nature of the inputs from a user and produce a more efficient human-machine interface. For battery-operated devices, such methods and interfaces conserve power and increase the time between battery charges.

The above deficiencies and other problems associated with user interfaces for electronic devices with touch-sensitive surfaces are reduced or eliminated by the disclosed devices. In some embodiments, the device is a desktop

2

computer. In some embodiments, the device is portable (e.g., a notebook computer, tablet computer, or handheld device). In some embodiments, the device is a personal electronic device (e.g., a wearable electronic device, such as a watch). In some embodiments, the device has a touchpad. In some embodiments, the device has a touch-sensitive display (also known as a “touch screen” or “touch-screen display”). In some embodiments, the device has a graphical user interface (GUI), one or more processors, memory and one or more modules, programs or sets of instructions stored in the memory for performing multiple functions. In some embodiments, the user interacts with the GUI primarily through stylus and/or finger contacts and gestures on the touch-sensitive surface. In some embodiments, the functions optionally include image editing, drawing, presenting, word processing, spreadsheet making, game playing, telephoning, video conferencing, e-mailing, instant messaging, workout support, digital photographing, digital videoing, web browsing, digital music playing, note taking, and/or digital video playing. Executable instructions for performing these functions are, optionally, included in a non-transitory computer readable storage medium or other computer program product configured for execution by one or more processors.

In accordance with some embodiments, a method is performed at a device having a display and a touch-sensitive surface. The method includes: while the device is in a screen-off state, receiving one or more notifications; after receiving the one or more notifications, detecting a first input from a user for waking the device from the screen-off state to a screen-on state; in response to detecting the first input for waking the device from the screen-off state to the screen-on state: transitioning the device from the screen-off state to the screen-on state; displaying a wake screen user interface on the display; and displaying the one or more notifications on the wake screen user interface; while displaying the wake screen user interface and while at least one of the one or more notifications remains displayed on the wake screen user interface, detecting a second input for dismissing the wake screen user interface; in response to detecting the second input for dismissing the wake screen user interface, ceasing to display the wake screen user interface and the at least one of the one or more notifications; after ceasing to display the wake screen user interface and the at least one of the one or more notifications in response to the second input, detecting a third input for redisplaying the wake screen user interface; in response to detecting the third input for redisplaying the wake screen user interface: in accordance with a determination that the third input meets notification-clearance criteria, wherein the notification-clearance criteria require that the third input is detected at a time that is (1) after a respective notification of the one or more notifications has been cleared through direct user interaction with the respective notification or an application that corresponds to the respective notification and (2) after the device has transitioned from the screen-on state to the screen-off state at least once since the detection of the second input, redisplaying the wake screen user interface without displaying the at least one of the one or more notifications on the redisplayed wake screen user interface; and in accordance with a determination that the third input does not meet the notification-clearance criteria: redisplaying the wake screen user interface, and redisplaying the at least one of the one or more notifications on the redisplayed wake screen user interface.

In accordance with some embodiments, a method is performed at a device having a display and a touch-sensitive surface. The method includes: displaying a first user inter-



US 11,106,352 B2

3

4

face, including displaying one or more missed notifications in a first scrollable arrangement on the first user interface; while displaying the first user interface with the one or more missed notifications, detecting a first swipe gesture, including detecting a first contact at a location on the touch-sensitive surface that corresponds to the first scrollable arrangement, and detecting first movement of the first contact across the touch-sensitive surface in a first direction; in response to detecting the first swipe gesture, scrolling the first scrollable arrangement in accordance with the first movement of the first contact; after scrolling the first scrollable arrangement in accordance with the first movement of the first contact, detecting a second swipe gesture, including detecting a second contact at a location on the touch-sensitive surface that corresponds to the first scrollable arrangement, and detecting second movement of the second contact across the touch-sensitive surface in the first direction; in response to detecting the second swipe gesture: in accordance with a determination that the second movement of the second contact meets notification-history-display criteria, wherein the notification-history-display criteria require (1) that the second movement of the second contact is detected after an end of the first scrollable arrangement has been reached in accordance with the first movement of the first contact and (2) that the second movement exceeds a first threshold amount of movement in the first direction, displaying a plurality of previously received notifications that are distinct from the one or more missed notifications in a second scrollable arrangement on the first user interface; and, in accordance with the determination that the second movement of the first contact does not meet the notification-history-display criteria, forgoing displaying the plurality of previously received notifications.

In accordance with some embodiments, a method is performed at a device having a display and a touch-sensitive surface. The method includes: displaying a first user interface on the display; displaying a first user interface object overlaid on a first portion of the first user interface; while displaying the first user interface object overlaid on the first portion of the first user interface, detecting a first input for displaying a cover sheet user interface, where the cover sheet user interface includes a first content object and a second content object displayed on a background object; in response to detecting the first input for displaying the cover sheet user interface, moving the cover sheet user interface across the display in a first direction, including: moving the background object of the cover sheet user interface across the display; in accordance with a determination that the first user interface object has not reached a predefined threshold position relative to the cover sheet user interface, moving the first content object and the second content object with the background object while maintaining a current position of the first user interface object on the display; and, in accordance with a determination that the first user interface object has reached the predefined threshold position relative to the cover sheet user interface, moving the first user interface object with the background object.

In accordance with some embodiments, a method is performed at a device having a display and a touch-sensitive surface. The method includes: while the device is in a screen-off state, detecting a first input for waking the device from the screen-off state to a screen-on state; and in response to detecting the first input for waking the device from the screen-off state to the screen-on state: transitioning the device from the screen-off state to the screen-on state, and displaying a wake screen user interface on the display; while displaying the wake screen user interface, detecting a first

swipe gesture on the touch-sensitive surface, including detecting a first contact on the touch-sensitive surface and detecting movement of the first contact across the touch-sensitive surface; in response to detecting the first swipe gesture: ceasing to display the wake screen user interface; and displaying a first user interface, wherein: in accordance with a determination that the first swipe gesture is in a first direction, the displayed first user interface is a mini-application-object user interface, wherein the mini-application-object user interface includes one or more mini-application objects that each provide a subset of functions of a corresponding application without launching the corresponding application; and, in accordance with a determination that the first swipe gesture is in a second direction that is opposite the first direction, the displayed first user interface is a control panel user interface, wherein the control panel user interface includes one or more device controls for controlling one or more device functions of the device.

In accordance with some embodiments, an electronic device includes a display, a touch-sensitive surface, optionally one or more sensors to detect intensities of contacts with the touch-sensitive surface, optionally one or more tactile output generators, one or more processors, and memory storing one or more programs; the one or more programs are configured to be executed by the one or more processors and the one or more programs include instructions for performing or causing performance of the operations of any of the methods described herein. In accordance with some embodiments, a computer readable storage medium has stored therein instructions, which, when executed by an electronic device with a display, a touch-sensitive surface, optionally one or more sensors to detect intensities of contacts with the touch-sensitive surface, and optionally one or more tactile output generators, cause the device to perform or cause performance of the operations of any of the methods described herein. In accordance with some embodiments, a graphical user interface on an electronic device with a display, a touch-sensitive surface, optionally one or more sensors to detect intensities of contacts with the touch-sensitive surface, optionally one or more tactile output generators, a memory, and one or more processors to execute one or more programs stored in the memory includes one or more of the elements displayed in any of the methods described herein, which are updated in response to inputs, as described in any of the methods described herein. In accordance with some embodiments, an electronic device includes: a display, a touch-sensitive surface, optionally one or more sensors to detect intensities of contacts with the touch-sensitive surface, and optionally one or more tactile output generators; and means for performing or causing performance of the operations of any of the methods described herein. In accordance with some embodiments, an information processing apparatus, for use in an electronic device with a display, a touch-sensitive surface, optionally one or more sensors to detect intensities of contacts with the touch-sensitive surface, and optionally one or more tactile output generators, includes means for performing or causing performance of the operations of any of the methods described herein.

Thus, electronic devices with displays, touch-sensitive surfaces, optionally one or more sensors to detect intensities of contacts with the touch-sensitive surface, optionally one or more tactile output generators, optionally one or more device orientation sensors, are provided with improved interfaces for accessing notifications and improved navigation to and from such interfaces, thereby increasing the effectiveness, efficiency, and user satisfaction with such

US 11,106,352 B2

5

devices. Such methods and interfaces may complement or replace conventional methods for providing accessing notifications.

BRIEF DESCRIPTION OF THE DRAWINGS

For a better understanding of the various described embodiments, reference should be made to the Description of Embodiments below, in conjunction with the following drawings in which like reference numerals refer to corresponding parts throughout the figures.

FIG. 1A is a block diagram illustrating a portable multifunction device with a touch-sensitive display, in accordance with some embodiments.

FIG. 1B is a block diagram illustrating example components for event handling, in accordance with some embodiments.

FIG. 1C is a block diagram illustrating a tactile output module, in accordance with some embodiments.

FIG. 2 illustrates a portable multifunction device having a touch screen, in accordance with some embodiments.

FIG. 3 is a block diagram of an example multifunction device with a display and a touch-sensitive surface, in accordance with some embodiments.

FIG. 4A illustrates an example user interface for a menu of applications on a portable multifunction device, in accordance with some embodiments.

FIG. 4B illustrates an example user interface for a multifunction device with a touch-sensitive surface that is separate from the display, in accordance with some embodiments.

FIGS. 4C-4E illustrate examples of dynamic intensity thresholds, in accordance with some embodiments.

FIGS. 5A1-5A4, 5B-5EB, 5EC1-5EC4, 5ED-5HR illustrate example user interfaces for providing access to notifications on a cover sheet user interface in accordance with some embodiments.

FIGS. 6A-6G are flow diagrams of a process for clearing sets of notifications, in accordance with some embodiments.

FIGS. 7A-7E are flow diagrams of a process for displaying notification history, in accordance with some embodiments.

FIGS. 8A-8C are flow diagrams of a process for displaying updating information from an application in a floating banner, in accordance with some embodiments.

FIGS. 9A-9C are flow diagrams of a process for navigation using a cover sheet, in accordance with some embodiments.

DESCRIPTION OF EMBODIMENTS

A number of different approaches for navigating to, displaying, and/or interacting with notification content and user interfaces that display notifications are described herein. Using one or more of these approaches (optionally in conjunction with each other) reduces the number, extent, and/or nature of the inputs from a user and provides a more efficient human-machine interface. For battery-operated devices, these improvements conserve power and increase the time between battery charges. These approaches describe improved methods for:

- clearing individual notifications and clearing sets of notifications;
- displaying notification history;
- displaying updating information from an application in a floating banner; and

6

navigating from a user interface that displays notifications to adjacent user interfaces that display device controls and/or application controls.

The methods, devices, and GUIs described herein display notifications on a cover sheet to present recent information received and/or generated by applications installed on a device, which makes the user-device interface more efficient in multiple ways. For example, they provide more efficient ways to retain sets of notifications, clear sets of notifications, display missed notifications, display previously cleared notifications in a notification history, access information from an active mode of an application using a banner that is displayed in user interfaces other than the application user interface, and access additional user interfaces from a cover sheet user interface.

Below, FIGS. 1A-1B, 2, and 3 provide a description of example devices. FIGS. 4A-4B and 5A-5HR illustrate example user interfaces for providing access to notifications on a cover sheet user interface. FIGS. 6A-6G illustrate a flow diagram of a method of clearing notifications in accordance with some embodiments. FIGS. 7A-7E illustrate a flow diagram of a method of displaying notification history in accordance with some embodiments. FIGS. 8A-8C illustrate a flow diagram of a method of displaying updating information from an application in a floating banner in accordance with some embodiments. FIGS. 9A-9C illustrate a flow diagram of a method of navigation using a cover sheet in accordance with some embodiments. The user interfaces in FIGS. 5A-5HR are used to illustrate the processes in FIGS. 6A-6G, 7A-7E, 8A-8C, and 9A-9C.

Example Devices

Reference will now be made in detail to embodiments, examples of which are illustrated in the accompanying drawings. In the following detailed description, numerous specific details are set forth in order to provide a thorough understanding of the various described embodiments. However, it will be apparent to one of ordinary skill in the art that the various described embodiments may be practiced without these specific details. In other instances, well-known methods, procedures, components, circuits, and networks have not been described in detail so as not to unnecessarily obscure aspects of the embodiments.

It will also be understood that, although the terms first, second, etc. are, in some instances, used herein to describe various elements, these elements should not be limited by these terms. These terms are only used to distinguish one element from another. For example, a first contact could be termed a second contact, and, similarly, a second contact could be termed a first contact, without departing from the scope of the various described embodiments. The first contact and the second contact are both contacts, but they are not the same contact, unless the context clearly indicates otherwise.

The terminology used in the description of the various described embodiments herein is for the purpose of describing particular embodiments only and is not intended to be limiting. As used in the description of the various described embodiments and the appended claims, the singular forms "a," "an," and "the" are intended to include the plural forms as well, unless the context clearly indicates otherwise. It will also be understood that the term "and/or" as used herein refers to and encompasses any and all possible combinations of one or more of the associated listed items. It will be further understood that the terms "includes," "including," "comprises," and/or "comprising," when used in this speci-



fication, specify the presence of stated features, integers, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, integers, steps, operations, elements, components, and/or groups thereof.

As used herein, the term “if” is, optionally, construed to mean “when” or “upon” or “in response to determining” or “in response to detecting,” depending on the context. Similarly, the phrase “if it is determined” or “if [a stated condition or event] is detected” is, optionally, construed to mean “upon determining” or “in response to determining” or “upon detecting [the stated condition or event]” or “in response to detecting [the stated condition or event],” depending on the context.

Embodiments of electronic devices, user interfaces for such devices, and associated processes for using such devices are described. In some embodiments, the device is a portable communications device, such as a mobile telephone, that also contains other functions, such as PDA and/or music player functions. Example embodiments of portable multifunction devices include, without limitation, the iPhone®, iPod Touch®, and iPad® devices from Apple Inc. of Cupertino, Calif. Other portable electronic devices, such as laptops or tablet computers with touch-sensitive surfaces (e.g., touch-screen displays and/or touchpads), are, optionally, used. It should also be understood that, in some embodiments, the device is not a portable communications device, but is a desktop computer with a touch-sensitive surface (e.g., a touch-screen display and/or a touchpad).

In the discussion that follows, an electronic device that includes a display and a touch-sensitive surface is described. It should be understood, however, that the electronic device optionally includes one or more other physical user-interface devices, such as a physical keyboard, a mouse and/or a joystick.

The device typically supports a variety of applications, such as one or more of the following: a note taking application, a drawing application, a presentation application, a word processing application, a website creation application, a disk authoring application, a spreadsheet application, a gaming application, a telephone application, a video conferencing application, an e-mail application, an instant messaging application, a workout support application, a photo management application, a digital camera application, a digital video camera application, a web browsing application, a digital music player application, and/or a digital video player application.

The various applications that are executed on the device optionally use at least one common physical user-interface device, such as the touch-sensitive surface. One or more functions of the touch-sensitive surface as well as corresponding information displayed on the device are, optionally, adjusted and/or varied from one application to the next and/or within a respective application. In this way, a common physical architecture (such as the touch-sensitive surface) of the device optionally supports the variety of applications with user interfaces that are intuitive and transparent to the user.

Attention is now directed toward embodiments of portable devices with touch-sensitive displays. FIG. 1A is a block diagram illustrating portable multifunction device 100 with touch-sensitive display system 112 in accordance with some embodiments. Touch-sensitive display system 112 is sometimes called a “touch screen” for convenience, and is sometimes simply called a touch-sensitive display. Device 100 includes memory 102 (which optionally includes one or more computer readable storage mediums), memory con-

troller 122, one or more processing units (CPUs) 120, peripherals interface 118, RF circuitry 108, audio circuitry 110, speaker 111, microphone 113, input/output (I/O) subsystem 106, other input or control devices 116, and external port 124. Device 100 optionally includes one or more optical sensors 164. Device 100 optionally includes one or more intensity sensors 165 for detecting intensities of contacts on device 100 (e.g., a touch-sensitive surface such as touch-sensitive display system 112 of device 100). Device 100 optionally includes one or more tactile output generators 167 for generating tactile outputs on device 100 (e.g., generating tactile outputs on a touch-sensitive surface such as touch-sensitive display system 112 of device 100 or touchpad 355 of device 300). These components optionally communicate over one or more communication buses or signal lines 103.

As used in the specification and claims, the term “tactile output” refers to physical displacement of a device relative to a previous position of the device, physical displacement of a component (e.g., a touch-sensitive surface) of a device relative to another component (e.g., housing) of the device, or displacement of the component relative to a center of mass of the device that will be detected by a user with the user’s sense of touch. For example, in situations where the device or the component of the device is in contact with a surface of a user that is sensitive to touch (e.g., a finger, palm, or other part of a user’s hand), the tactile output generated by the physical displacement will be interpreted by the user as a tactile sensation corresponding to a perceived change in physical characteristics of the device or the component of the device. For example, movement of a touch-sensitive surface (e.g., a touch-sensitive display or trackpad) is, optionally, interpreted by the user as a “down click” or “up click” of a physical actuator button. In some cases, a user will feel a tactile sensation such as an “down click” or “up click” even when there is no movement of a physical actuator button associated with the touch-sensitive surface that is physically pressed (e.g., displaced) by the user’s movements. As another example, movement of the touch-sensitive surface is, optionally, interpreted or sensed by the user as “roughness” of the touch-sensitive surface, even when there is no change in smoothness of the touch-sensitive surface. While such interpretations of touch by a user will be subject to the individualized sensory perceptions of the user, there are many sensory perceptions of touch that are common to a large majority of users. Thus, when a tactile output is described as corresponding to a particular sensory perception of a user (e.g., an “up click,” a “down click,” “roughness”), unless otherwise stated, the generated tactile output corresponds to physical displacement of the device or a component thereof that will generate the described sensory perception for a typical (or average) user. Using tactile outputs to provide haptic feedback to a user enhances the operability of the device and makes the user-device interface more efficient (e.g., by helping the user to provide proper inputs and reducing user mistakes when operating/interacting with the device) which, additionally, reduces power usage and improves battery life of the device by enabling the user to use the device more quickly and efficiently.

In some embodiments, a tactile output pattern specifies characteristics of a tactile output, such as the amplitude of the tactile output, the shape of a movement waveform of the tactile output, the frequency of the tactile output, and/or the duration of the tactile output.

When tactile outputs with different tactile output patterns are generated by a device (e.g., via one or more tactile output generators that move a moveable mass to generate tactile outputs), the tactile outputs may invoke different haptic



US 11,106,352 B2

9

sensations in a user holding or touching the device. While the sensation of the user is based on the user's perception of the tactile output, most users will be able to identify changes in waveform, frequency, and amplitude of tactile outputs generated by the device. Thus, the waveform, frequency and amplitude can be adjusted to indicate to the user that different operations have been performed. As such, tactile outputs with tactile output patterns that are designed, selected, and/or engineered to simulate characteristics (e.g., size, material, weight, stiffness, smoothness, etc.); behaviors (e.g., oscillation, displacement, acceleration, rotation, expansion, etc.); and/or interactions (e.g., collision, adhesion, repulsion, attraction, friction, etc.) of objects in a given environment (e.g., a user interface that includes graphical features and objects, a simulated physical environment with virtual boundaries and virtual objects, a real physical environment with physical boundaries and physical objects, and/or a combination of any of the above) will, in some circumstances, provide helpful feedback to users that reduces input errors and increases the efficiency of the user's operation of the device. Additionally, tactile outputs are, optionally, generated to correspond to feedback that is unrelated to a simulated physical characteristic, such as an input threshold or a selection of an object. Such tactile outputs will, in some circumstances, provide helpful feedback to users that reduces input errors and increases the efficiency of the user's operation of the device.

In some embodiments, a tactile output with a suitable tactile output pattern serves as a cue for the occurrence of an event of interest in a user interface or behind the scenes in a device. Examples of the events of interest include activation of an affordance (e.g., a real or virtual button, or toggle switch) provided on the device or in a user interface, success or failure of a requested operation, reaching or crossing a boundary in a user interface, entry into a new state, switching of input focus between objects, activation of a new mode, reaching or crossing an input threshold, detection or recognition of a type of input or gesture, etc. In some embodiments, tactile outputs are provided to serve as a warning or an alert for an impending event or outcome that would occur unless a redirection or interruption input is timely detected. Tactile outputs are also used in other contexts to enrich the user experience, improve the accessibility of the device to users with visual or motor difficulties or other accessibility needs, and/or improve efficiency and functionality of the user interface and/or the device. Tactile outputs are optionally accompanied with audio outputs and/or visible user interface changes, which further enhance a user's experience when the user interacts with a user interface and/or the device, and facilitate better conveyance of information regarding the state of the user interface and/or the device, and which reduce input errors and increase the efficiency of the user's operation of the device.

It should be appreciated that device 100 is only one example of a portable multifunction device, and that device 100 optionally has more or fewer components than shown, optionally combines two or more components, or optionally has a different configuration or arrangement of the components. The various components shown in FIG. 1A are implemented in hardware, software, firmware, or a combination thereof, including one or more signal processing and/or application specific integrated circuits.

Memory 102 optionally includes high-speed random access memory and optionally also includes non-volatile memory, such as one or more magnetic disk storage devices, flash memory devices, or other non-volatile solid-state memory devices. Access to memory 102 by other compo-

10

nents of device 100, such as CPU(s) 120 and the peripherals interface 118, is, optionally, controlled by memory controller 122.

Peripherals interface 118 can be used to couple input and output peripherals of the device to CPU(s) 120 and memory 102. The one or more processors 120 run or execute various software programs and/or sets of instructions stored in memory 102 to perform various functions for device 100 and to process data.

In some embodiments, peripherals interface 118, CPU(s) 120, and memory controller 122 are, optionally, implemented on a single chip, such as chip 104. In some other embodiments, they are, optionally, implemented on separate chips.

RF (radio frequency) circuitry 108 receives and sends RF signals, also called electromagnetic signals. RF circuitry 108 converts electrical signals to/from electromagnetic signals and communicates with communications networks and other communications devices via the electromagnetic signals. RF circuitry 108 optionally includes well-known circuitry for performing these functions, including but not limited to an antenna system, an RF transceiver, one or more amplifiers, a tuner, one or more oscillators, a digital signal processor, a CODEC chipset, a subscriber identity module (SIM) card, memory, and so forth. RF circuitry 108 optionally communicates with networks, such as the Internet, also referred to as the World Wide Web (WWW), an intranet and/or a wireless network, such as a cellular telephone network, a wireless local area network (LAN) and/or a metropolitan area network (MAN), and other devices by wireless communication. The wireless communication optionally uses any of a plurality of communications standards, protocols and technologies, including but not limited to Global System for Mobile Communications (GSM), Enhanced Data GSM Environment (EDGE), high-speed downlink packet access (HSDPA), high-speed uplink packet access (HSDPA), Evolution, Data-Only (EV-DO), HSPA, HSPA+, Dual-Cell HSPA (DC-HSPA), long term evolution (LTE), near field communication (NFC), wideband code division multiple access (W-CDMA), code division multiple access (CDMA), time division multiple access (TDMA), Bluetooth, Wireless Fidelity (Wi-Fi) (e.g., IEEE 802.11a, IEEE 802.11ac, IEEE 802.11ax, IEEE 802.11b, IEEE 802.11g and/or IEEE 802.11n), voice over Internet Protocol (VoIP), Wi-MAX, a protocol for e-mail (e.g., Internet message access protocol (IMAP) and/or post office protocol (POP)), instant messaging (e.g., extensible messaging and presence protocol (XMPP), Session Initiation Protocol for Instant Messaging and Presence Leveraging Extensions (SIMPLE), Instant Messaging and Presence Service (IMPS)), and/or Short Message Service (SMS), or any other suitable communication protocol, including communication protocols not yet developed as of the filing date of this document.

Audio circuitry 110, speaker 111, and microphone 113 provide an audio interface between a user and device 100. Audio circuitry 110 receives audio data from peripherals interface 118, converts the audio data to an electrical signal, and transmits the electrical signal to speaker 111. Speaker 111 converts the electrical signal to human-audible sound waves. Audio circuitry 110 also receives electrical signals converted by microphone 113 from sound waves. Audio circuitry 110 converts the electrical signal to audio data and transmits the audio data to peripherals interface 118 for processing. Audio data is, optionally, retrieved from and/or transmitted to memory 102 and/or RF circuitry 108 by peripherals interface 118. In some embodiments, audio circuitry 110 also includes a headset jack (e.g., 212, FIG. 2).

US 11,106,352 B2

11

The headset jack provides an interface between audio circuitry 110 and removable audio input/output peripherals, such as output-only headphones or a headset with both output (e.g., a headphone for one or both ears) and input (e.g., a microphone).

I/O subsystem 106 couples input/output peripherals on device 100, such as touch-sensitive display system 112 and other input or control devices 116, with peripherals interface 118. I/O subsystem 106 optionally includes display controller 156, optical sensor controller 158, intensity sensor controller 159, haptic feedback controller 161, and one or more input controllers 160 for other input or control devices. The one or more input controllers 160 receive/send electrical signals from/to other input or control devices 116. The other input or control devices 116 optionally include physical buttons (e.g., push buttons, rocker buttons, etc.), dials, slider switches, joysticks, click wheels, and so forth. In some alternate embodiments, input controller(s) 160 are, optionally, coupled with any (or none) of the following: a keyboard, infrared port, USB port, stylus, and/or a pointer device such as a mouse. The one or more buttons (e.g., 208, FIG. 2) optionally include an up/down button for volume control of speaker 111 and/or microphone 113. The one or more buttons optionally include a push button (e.g., 206, FIG. 2).

Touch-sensitive display system 112 provides an input interface and an output interface between the device and a user. Display controller 156 receives and/or sends electrical signals from/to touch-sensitive display system 112. Touch-sensitive display system 112 displays visual output to the user. The visual output optionally includes graphics, text, icons, video, and any combination thereof (collectively termed "graphics"). In some embodiments, some or all of the visual output corresponds to user interface objects. As used herein, the term "affordance" refers to a user-interactive graphical user interface object (e.g., a graphical user interface object that is configured to respond to inputs directed toward the graphical user interface object). Examples of user-interactive graphical user interface objects include, without limitation, a button, slider, icon, selectable menu item, switch, hyperlink, or other user interface control.

Touch-sensitive display system 112 has a touch-sensitive surface, sensor or set of sensors that accepts input from the user based on haptic and/or tactile contact. Touch-sensitive display system 112 and display controller 156 (along with any associated modules and/or sets of instructions in memory 102) detect contact (and any movement or breaking of the contact) on touch-sensitive display system 112 and converts the detected contact into interaction with user-interface objects (e.g., one or more soft keys, icons, web pages or images) that are displayed on touch-sensitive display system 112. In some embodiments, a point of contact between touch-sensitive display system 112 and the user corresponds to a finger of the user or a stylus.

Touch-sensitive display system 112 optionally uses LCD (liquid crystal display) technology, LPD (light emitting polymer display) technology, or LED (light emitting diode) technology, although other display technologies are used in other embodiments. Touch-sensitive display system 112 and display controller 156 optionally detect contact and any movement or breaking thereof using any of a plurality of touch sensing technologies now known or later developed, including but not limited to capacitive, resistive, infrared, and surface acoustic wave technologies, as well as other proximity sensor arrays or other elements for determining one or more points of contact with touch-sensitive display system 112. In some embodiments, projected mutual capaci-

12

tance sensing technology is used, such as that found in the iPhone®, iPod Touch®, and iPad® from Apple Inc. of Cupertino, Calif.

Touch-sensitive display system 112 optionally has a video resolution in excess of 100 dpi. In some embodiments, the touch screen video resolution is in excess of 400 dpi (e.g., 500 dpi, 800 dpi, or greater). The user optionally makes contact with touch-sensitive display system 112 using any suitable object or appendage, such as a stylus, a finger, and so forth. In some embodiments, the user interface is designed to work with finger-based contacts and gestures, which can be less precise than stylus-based input due to the larger area of contact of a finger on the touch screen. In some embodiments, the device translates the rough finger-based input into a precise pointer/cursor position or command for performing the actions desired by the user.

In some embodiments, in addition to the touch screen, device 100 optionally includes a touchpad (not shown) for activating or deactivating particular functions. In some embodiments, the touchpad is a touch-sensitive area of the device that, unlike the touch screen, does not display visual output. The touchpad is, optionally, a touch-sensitive surface that is separate from touch-sensitive display system 112 or an extension of the touch-sensitive surface formed by the touch screen.

Device 100 also includes power system 162 for powering the various components. Power system 162 optionally includes a power management system, one or more power sources (e.g., battery, alternating current (AC)), a recharging system, a power failure detection circuit, a power converter or inverter, a power status indicator (e.g., a light-emitting diode (LED)) and any other components associated with the generation, management and distribution of power in portable devices.

Device 100 optionally also includes one or more optical sensors 164. FIG. 1A shows an optical sensor coupled with optical sensor controller 158 in I/O subsystem 106. Optical sensor(s) 164 optionally include charge-coupled device (CCD) or complementary metal-oxide semiconductor (CMOS) phototransistors. Optical sensor(s) 164 receive light from the environment, projected through one or more lens, and converts the light to data representing an image. In conjunction with imaging module 143 (also called a camera module), optical sensor(s) 164 optionally capture still images and/or video. In some embodiments, an optical sensor is located on the back of device 100, opposite touch-sensitive display system 112 on the front of the device, so that the touch screen is enabled for use as a viewfinder for still and/or video image acquisition. In some embodiments, another optical sensor is located on the front of the device so that the user's image is obtained (e.g., for selfies, for videoconferencing while the user views the other video conference participants on the touch screen, etc.).

Device 100 optionally also includes one or more contact intensity sensors 165. FIG. 1A shows a contact intensity sensor coupled with intensity sensor controller 159 in I/O subsystem 106. Contact intensity sensor(s) 165 optionally include one or more piezoresistive strain gauges, capacitive force sensors, electric force sensors, piezoelectric force sensors, optical force sensors, capacitive touch-sensitive surfaces, or other intensity sensors (e.g., sensors used to measure the force (or pressure) of a contact on a touch-sensitive surface). Contact intensity sensor(s) 165 receive contact intensity information (e.g., pressure information or a proxy for pressure information) from the environment. In some embodiments, at least one contact intensity sensor is collocated with, or proximate to, a touch-sensitive surface



## US 11,106,352 B2

13

(e.g., touch-sensitive display system 112). In some embodiments, at least one contact intensity sensor is located on the back of device 100, opposite touch-screen display system 112 which is located on the front of device 100.

Device 100 optionally also includes one or more proximity sensors 166. FIG. 1A shows proximity sensor 166 coupled with peripherals interface 118. Alternately, proximity sensor 166 is coupled with input controller 160 in I/O subsystem 106. In some embodiments, the proximity sensor turns off and disables touch-sensitive display system 112 when the multifunction device is placed near the user's ear (e.g., when the user is making a phone call).

Device 100 optionally also includes one or more tactile output generators 167. FIG. 1A shows a tactile output generator coupled with haptic feedback controller 161 in I/O subsystem 106. In some embodiments, tactile output generator(s) 167 include one or more electroacoustic devices such as speakers or other audio components and/or electro-mechanical devices that convert energy into linear motion such as a motor, solenoid, electroactive polymer, piezoelectric actuator, electrostatic actuator, or other tactile output generating component (e.g., a component that converts electrical signals into tactile outputs on the device). Tactile output generator(s) 167 receive tactile feedback generation instructions from haptic feedback module 133 and generates tactile outputs on device 100 that are capable of being sensed by a user of device 100. In some embodiments, at least one tactile output generator is collocated with, or proximate to, a touch-sensitive surface (e.g., touch-sensitive display system 112) and, optionally, generates a tactile output by moving the touch-sensitive surface vertically (e.g., in/out of a surface of device 100) or laterally (e.g., back and forth in the same plane as a surface of device 100). In some embodiments, at least one tactile output generator sensor is located on the back of device 100, opposite touch-sensitive display system 112, which is located on the front of device 100.

Device 100 optionally also includes one or more accelerometers 168. FIG. 1A shows accelerometer 168 coupled with peripherals interface 118. Alternately, accelerometer 168 is, optionally, coupled with an input controller 160 in I/O subsystem 106. In some embodiments, information is displayed on the touch-screen display in a portrait view or a landscape view based on an analysis of data received from the one or more accelerometers. Device 100 optionally includes, in addition to accelerometer(s) 168, a magnetometer (not shown) and a GPS (or GLONASS or other global navigation system) receiver (not shown) for obtaining information concerning the location and orientation (e.g., portrait or landscape) of device 100.

In some embodiments, the software components stored in memory 102 include operating system 126, communication module (or set of instructions) 128, contact/motion module (or set of instructions) 130, graphics module (or set of instructions) 132, haptic feedback module (or set of instructions) 133, text input module (or set of instructions) 134, Global Positioning System (GPS) module (or set of instructions) 135, and applications (or sets of instructions) 136. Furthermore, in some embodiments, memory 102 stores device/global internal state 157, as shown in FIGS. 1A and 3. Device/global internal state 157 includes one or more of: active application state, indicating which applications, if any, are currently active; display state, indicating what applications, views or other information occupy various regions of touch-sensitive display system 112; sensor state, including information obtained from the device's various

14

sensors and other input or control devices 116; and location and/or positional information concerning the device's location and/or attitude.

Operating system 126 (e.g., iOS, Darwin, RTXC, LINUX, UNIX, OS X, WINDOWS, or an embedded operating system such as VxWorks) includes various software components and/or drivers for controlling and managing general system tasks (e.g., memory management, storage device control, power management, etc.) and facilitates communication between various hardware and software components.

Communication module 128 facilitates communication with other devices over one or more external ports 124 and also includes various software components for handling data received by RF circuitry 108 and/or external port 124. External port 124 (e.g., Universal Serial Bus (USB), FIREWIRE, etc.) is adapted for coupling directly to other devices or indirectly over a network (e.g., the Internet, wireless LAN, etc.). In some embodiments, the external port is a multi-pin (e.g., 30-pin) connector that is the same as, or similar to and/or compatible with the 30-pin connector used in some iPhone®, iPod Touch®, and iPad® devices from Apple Inc. of Cupertino, Calif. In some embodiments, the external port is a Lightning connector that is the same as, or similar to and/or compatible with the Lightning connector used in some iPhone®, iPod Touch®, and iPad® devices from Apple Inc. of Cupertino, Calif.

Contact/motion module 130 optionally detects contact with touch-sensitive display system 112 (in conjunction with display controller 156) and other touch-sensitive devices (e.g., a touchpad or physical click wheel). Contact/motion module 130 includes various software components for performing various operations related to detection of contact (e.g., by a finger or by a stylus), such as determining if contact has occurred (e.g., detecting a finger-down event), determining an intensity of the contact (e.g., the force or pressure of the contact or a substitute for the force or pressure of the contact), determining if there is movement of the contact and tracking the movement across the touch-sensitive surface (e.g., detecting one or more finger-dragging events), and determining if the contact has ceased (e.g., detecting a finger-up event or a break in contact). Contact/motion module 130 receives contact data from the touch-sensitive surface. Determining movement of the point of contact, which is represented by a series of contact data, optionally includes determining speed (magnitude), velocity (magnitude and direction), and/or an acceleration (a change in magnitude and/or direction) of the point of contact. These operations are, optionally, applied to single contacts (e.g., one finger contacts or stylus contacts) or to multiple simultaneous contacts (e.g., "multitouch"/multiple finger contacts). In some embodiments, contact/motion module 130 and display controller 156 detect contact on a touchpad.

Contact/motion module 130 optionally detects a gesture input by a user. Different gestures on the touch-sensitive surface have different contact patterns (e.g., different motions, timings, and/or intensities of detected contacts). Thus, a gesture is, optionally, detected by detecting a particular contact pattern. For example, detecting a finger tap gesture includes detecting a finger-down event followed by detecting a finger-up (lift off) event at the same position (or substantially the same position) as the finger-down event (e.g., at the position of an icon). As another example, detecting a finger swipe gesture on the touch-sensitive surface includes detecting a finger-down event followed by detecting one or more finger-dragging events, and subsequently followed by detecting a finger-up (lift off) event.

US 11,106,352 B2

15

Similarly, tap, swipe, drag, and other gestures are optionally detected for a stylus by detecting a particular contact pattern for the stylus.

In some embodiments, detecting a finger tap gesture depends on the length of time between detecting the finger-down event and the finger-up event, but is independent of the intensity of the finger contact between detecting the finger-down event and the finger-up event. In some embodiments, a tap gesture is detected in accordance with a determination that the length of time between the finger-down event and the finger-up event is less than a predetermined value (e.g., less than 0.1, 0.2, 0.3, 0.4 or 0.5 seconds), independent of whether the intensity of the finger contact during the tap meets a given intensity threshold (greater than a nominal contact-detection intensity threshold), such as a light press or deep press intensity threshold. Thus, a finger tap gesture can satisfy particular input criteria that do not require that the characteristic intensity of a contact satisfy a given intensity threshold in order for the particular input criteria to be met. For clarity, the finger contact in a tap gesture typically needs to satisfy a nominal contact-detection intensity threshold, below which the contact is not detected, in order for the finger-down event to be detected. A similar analysis applies to detecting a tap gesture by a stylus or other contact. In cases where the device is capable of detecting a finger or stylus contact hovering over a touch sensitive surface, the nominal contact-detection intensity threshold optionally does not correspond to physical contact between the finger or stylus and the touch sensitive surface.

The same concepts apply in an analogous manner to other types of gestures. For example, a swipe gesture, a pinch gesture, a depinch gesture, and/or a long press gesture are optionally detected based on the satisfaction of criteria that are either independent of intensities of contacts included in the gesture, or do not require that contact(s) that perform the gesture reach intensity thresholds in order to be recognized. For example, a swipe gesture is detected based on an amount of movement of one or more contacts; a pinch gesture is detected based on movement of two or more contacts towards each other; a depinch gesture is detected based on movement of two or more contacts away from each other; and a long press gesture is detected based on a duration of the contact on the touch-sensitive surface with less than a threshold amount of movement. As such, the statement that particular gesture recognition criteria do not require that the intensity of the contact(s) meet a respective intensity threshold in order for the particular gesture recognition criteria to be met means that the particular gesture recognition criteria are capable of being satisfied if the contact(s) in the gesture do not reach the respective intensity threshold, and are also capable of being satisfied in circumstances where one or more of the contacts in the gesture do reach or exceed the respective intensity threshold. In some embodiments, a tap gesture is detected based on a determination that the finger-down and finger-up event are detected within a predefined time period, without regard to whether the contact is above or below the respective intensity threshold during the predefined time period, and a swipe gesture is detected based on a determination that the contact movement is greater than a predefined magnitude, even if the contact is above the respective intensity threshold at the end of the contact movement. Even in implementations where detection of a gesture is influenced by the intensity of contacts performing the gesture (e.g., the device detects a long press more quickly when the intensity of the contact is above an intensity threshold or delays detection of a tap input when the intensity of the contact is higher), the detection of those

16

gestures does not require that the contacts reach a particular intensity threshold so long as the criteria for recognizing the gesture can be met in circumstances where the contact does not reach the particular intensity threshold (e.g., even if the amount of time that it takes to recognize the gesture changes).

Contact intensity thresholds, duration thresholds, and movement thresholds are, in some circumstances, combined in a variety of different combinations in order to create heuristics for distinguishing two or more different gestures directed to the same input element or region so that multiple different interactions with the same input element are enabled to provide a richer set of user interactions and responses. The statement that a particular set of gesture recognition criteria do not require that the intensity of the contact(s) meet a respective intensity threshold in order for the particular gesture recognition criteria to be met does not preclude the concurrent evaluation of other intensity-dependent gesture recognition criteria to identify other gestures that do have a criteria that is met when a gesture includes a contact with an intensity above the respective intensity threshold. For example, in some circumstances, first gesture recognition criteria for a first gesture—which do not require that the intensity of the contact(s) meet a respective intensity threshold in order for the first gesture recognition criteria to be met—are in competition with second gesture recognition criteria for a second gesture—which are dependent on the contact(s) reaching the respective intensity threshold. In such competitions, the gesture is, optionally, not recognized as meeting the first gesture recognition criteria for the first gesture if the second gesture recognition criteria for the second gesture are met first. For example, if a contact reaches the respective intensity threshold before the contact moves by a predefined amount of movement, a deep press gesture is detected rather than a swipe gesture. Conversely, if the contact moves by the predefined amount of movement before the contact reaches the respective intensity threshold, a swipe gesture is detected rather than a deep press gesture. Even in such circumstances, the first gesture recognition criteria for the first gesture still do not require that the intensity of the contact(s) meet a respective intensity threshold in order for the first gesture recognition criteria to be met because if the contact stayed below the respective intensity threshold until an end of the gesture (e.g., a swipe gesture with a contact that does not increase to an intensity above the respective intensity threshold), the gesture would have been recognized by the first gesture recognition criteria as a swipe gesture. As such, particular gesture recognition criteria that do not require that the intensity of the contact(s) meet a respective intensity threshold in order for the particular gesture recognition criteria to be met will (A) in some circumstances ignore the intensity of the contact with respect to the intensity threshold (e.g. for a tap gesture) and/or (B) in some circumstances still be dependent on the intensity of the contact with respect to the intensity threshold in the sense that the particular gesture recognition criteria (e.g., for a long press gesture) will fail if a competing set of intensity-dependent gesture recognition criteria (e.g., for a deep press gesture) recognize an input as corresponding to an intensity-dependent gesture before the particular gesture recognition criteria recognize a gesture corresponding to the input (e.g., for a long press gesture that is competing with a deep press gesture for recognition).

Graphics module 132 includes various known software components for rendering and displaying graphics on touch-sensitive display system 112 or other display, including components for changing the visual impact (e.g., brightness,



## US 11,106,352 B2

17

transparency, saturation, contrast or other visual property) of graphics that are displayed. As used herein, the term "graphics" includes any object that can be displayed to a user, including without limitation text, web pages, icons (such as user-interface objects including soft keys), digital images, videos, animations and the like.

In some embodiments, graphics module 132 stores data representing graphics to be used. Each graphic is, optionally, assigned a corresponding code. Graphics module 132 receives, from applications etc., one or more codes specifying graphics to be displayed along with, if necessary, coordinate data and other graphic property data, and then generates screen image data to output to display controller 156.

Haptic feedback module 133 includes various software components for generating instructions (e.g., instructions used by haptic feedback controller 161) to produce tactile outputs using tactile output generator(s) 167 at one or more locations on device 100 in response to user interactions with device 100.

Text input module 134, which is, optionally, a component of graphics module 132, provides soft keyboards for entering text in various applications (e.g., contacts 137, e-mail 140, IM 141, browser 147, and any other application that needs text input).

GPS module 135 determines the location of the device and provides this information for use in various applications (e.g., to telephone 138 for use in location-based dialing, to camera 143 as picture/video metadata, and to applications that provide location-based services such as weather mini applications, local yellow page mini applications, and map/navigation mini applications).

Applications 136 optionally include the following modules (or sets of instructions), or a subset or superset thereof: contacts module 137 (sometimes called an address book or contact list);

telephone module 138;

video conferencing module 139;

e-mail client module 140;

instant messaging (IM) module 141;

workout support module 142;

camera module 143 for still and/or video images;

image management module 144;

browser module 147;

calendar module 148;

mini application modules 149, which optionally include one or more of: weather mini application 149-1, stocks mini application 149-2, calculator mini application 149-3, alarm clock mini application 149-4, dictionary mini application 149-5, and other mini applications obtained by the user, as well as user-created mini applications 149-6;

mini application creator module 150 for making user-created mini applications 149-6;

search module 151;

video and music player module 152, which is, optionally, made up of a video player module and a music player module;

notes module 153;

map module 154; and/or

online video module 155.

Examples of other applications 136 that are, optionally, stored in memory 102 include other word processing applications, other image editing applications, drawing applications, presentation applications, JAVA-enabled applications, encryption, digital rights management, voice recognition, and voice replication.

18

In conjunction with touch-sensitive display system 112, display controller 156, contact module 130, graphics module 132, and text input module 134, contacts module 137 includes executable instructions to manage an address book or contact list (e.g., stored in application internal state 192 of contacts module 137 in memory 102 or memory 370), including: adding name(s) to the address book; deleting name(s) from the address book; associating telephone number(s), e-mail address(es), physical address(es) or other information with a name; associating an image with a name; categorizing and sorting names; providing telephone numbers and/or e-mail addresses to initiate and/or facilitate communications by telephone 138, video conference 139, e-mail 140, or IM 141; and so forth.

In conjunction with RF circuitry 108, audio circuitry 110, speaker 111, microphone 113, touch-sensitive display system 112, display controller 156, contact module 130, graphics module 132, and text input module 134, telephone module 138 includes executable instructions to enter a sequence of characters corresponding to a telephone number, access one or more telephone numbers in address book 137, modify a telephone number that has been entered, dial a respective telephone number, conduct a conversation and disconnect or hang up when the conversation is completed. As noted above, the wireless communication optionally uses any of a plurality of communications standards, protocols and technologies.

In conjunction with RF circuitry 108, audio circuitry 110, speaker 111, microphone 113, touch-sensitive display system 112, display controller 156, optical sensor(s) 164, optical sensor controller 158, contact module 130, graphics module 132, text input module 134, contact list 137, and telephone module 138, videoconferencing module 139 includes executable instructions to initiate, conduct, and terminate a video conference between a user and one or more other participants in accordance with user instructions.

In conjunction with RF circuitry 108, touch-sensitive display system 112, display controller 156, contact module 130, graphics module 132, and text input module 134, e-mail client module 140 includes executable instructions to create, send, receive, and manage e-mail in response to user instructions. In conjunction with image management module 144, e-mail client module 140 makes it very easy to create and send e-mails with still or video images taken with camera module 143.

In conjunction with RF circuitry 108, touch-sensitive display system 112, display controller 156, contact module 130, graphics module 132, and text input module 134, the instant messaging module 141 includes executable instructions to enter a sequence of characters corresponding to an instant message, to modify previously entered characters, to transmit a respective instant message (for example, using a Short Message Service (SMS) or Multimedia Message Service (MMS) protocol for telephony-based instant messages or using XMPP, SIMPLE, Apple Push Notification Service (APNs) or IMPS for Internet-based instant messages), to receive instant messages, and to view received instant messages. In some embodiments, transmitted and/or received instant messages optionally include graphics, photos, audio files, video files and/or other attachments as are supported in a MMS and/or an Enhanced Messaging Service (EMS). As used herein, "instant messaging" refers to both telephony-based messages (e.g., messages sent using SMS or MMS) and Internet-based messages (e.g., messages sent using XMPP, SIMPLE, APNs, or IMPS).

In conjunction with RF circuitry 108, touch-sensitive display system 112, display controller 156, contact module

US 11,106,352 B2

19

130, graphics module 132, text input module 134, GPS module 135, map module 154, and video and music player module 152, workout support module 142 includes executable instructions to create workouts (e.g., with time, distance, and/or calorie burning goals); communicate with workout sensors (in sports devices and smart watches); receive workout sensor data; calibrate sensors used to monitor a workout; select and play music for a workout; and display, store and transmit workout data.

In conjunction with touch-sensitive display system 112, display controller 156, optical sensor(s) 164, optical sensor controller 158, contact module 130, graphics module 132, and image management module 144, camera module 143 includes executable instructions to capture still images or video (including a video stream) and store them into memory 102, modify characteristics of a still image or video, and/or delete a still image or video from memory 102.

In conjunction with touch-sensitive display system 112, display controller 156, contact module 130, graphics module 132, text input module 134, and camera module 143, image management module 144 includes executable instructions to arrange, modify (e.g., edit), or otherwise manipulate, label, delete, present (e.g., in a digital slide show or album), and store still and/or video images.

In conjunction with RF circuitry 108, touch-sensitive display system 112, display system controller 156, contact module 130, graphics module 132, and text input module 134, browser module 147 includes executable instructions to browse the Internet in accordance with user instructions, including searching, linking to, receiving, and displaying web pages or portions thereof, as well as attachments and other files linked to web pages.

In conjunction with RF circuitry 108, touch-sensitive display system 112, display system controller 156, contact module 130, graphics module 132, text input module 134, e-mail client module 140, and browser module 147, calendar module 148 includes executable instructions to create, display, modify, and store calendars and data associated with calendars (e.g., calendar entries, to do lists, etc.) in accordance with user instructions.

In conjunction with RF circuitry 108, touch-sensitive display system 112, display system controller 156, contact module 130, graphics module 132, text input module 134, and browser module 147, mini application modules 149 are mini-applications that are, optionally, downloaded and used by a user (e.g., weather mini application 149-1, stocks mini application 149-2, calculator mini application 149-3, alarm clock mini application 149-4, and dictionary mini application 149-5) or created by the user (e.g., user-created mini application 149-6). In some embodiments, a mini application includes an HTML (Hypertext Markup Language) file, a CSS (Cascading Style Sheets) file, and a JavaScript file. In some embodiments, a mini application includes an XML (Extensible Markup Language) file and a JavaScript file (e.g., Yahoo! Mini applications).

In conjunction with RF circuitry 108, touch-sensitive display system 112, display system controller 156, contact module 130, graphics module 132, text input module 134, and browser module 147, the mini application creator module 150 includes executable instructions to create mini applications (e.g., turning a user-specified portion of a web page into a mini application).

In conjunction with touch-sensitive display system 112, display system controller 156, contact module 130, graphics module 132, and text input module 134, search module 151 includes executable instructions to search for text, music, sound, image, video, and/or other files in memory 102 that

20

match one or more search criteria (e.g., one or more user-specified search terms) in accordance with user instructions.

In conjunction with touch-sensitive display system 112, display system controller 156, contact module 130, graphics module 132, audio circuitry 110, speaker 111, RF circuitry 108, and browser module 147, video and music player module 152 includes executable instructions that allow the user to download and play back recorded music and other sound files stored in one or more file formats, such as MP3 or AAC files, and executable instructions to display, present or otherwise play back videos (e.g., on touch-sensitive display system 112, or on an external display connected wirelessly or via external port 124). In some embodiments, device 100 optionally includes the functionality of an MP3 player, such as an iPod (trademark of Apple Inc.).

In conjunction with touch-sensitive display system 112, display controller 156, contact module 130, graphics module 132, and text input module 134, notes module 153 includes executable instructions to create and manage notes, to do lists, and the like in accordance with user instructions.

In conjunction with RF circuitry 108, touch-sensitive display system 112, display system controller 156, contact module 130, graphics module 132, text input module 134, GPS module 135, and browser module 147, map module 154 includes executable instructions to receive, display, modify, and store maps and data associated with maps (e.g., driving directions; data on stores and other points of interest at or near a particular location; and other location-based data) in accordance with user instructions.

In conjunction with touch-sensitive display system 112, display system controller 156, contact module 130, graphics module 132, audio circuitry 110, speaker 111, RF circuitry 108, text input module 134, e-mail client module 140, and browser module 147, online video module 155 includes executable instructions that allow the user to access, browse, receive (e.g., by streaming and/or download), play back (e.g., on the touch screen 112, or on an external display connected wirelessly or via external port 124), send an e-mail with a link to a particular online video, and otherwise manage online videos in one or more file formats, such as H.264. In some embodiments, instant messaging module 141, rather than e-mail client module 140, is used to send a link to a particular online video.

Each of the above identified modules and applications correspond to a set of executable instructions for performing one or more functions described above and the methods described in this application (e.g., the computer-implemented methods and other information processing methods described herein). These modules (i.e., sets of instructions) need not be implemented as separate software programs, procedures or modules, and thus various subsets of these modules are, optionally, combined or otherwise re-arranged in various embodiments. In some embodiments, memory 102 optionally stores a subset of the modules and data structures identified above. Furthermore, memory 102 optionally stores additional modules and data structures not described above.

In some embodiments, device 100 is a device where operation of a predefined set of functions on the device is performed exclusively through a touch screen and/or a touchpad. By using a touch screen and/or a touchpad as the primary input control device for operation of device 100, the number of physical input control devices (such as push buttons, dials, and the like) on device 100 is, optionally, reduced.

The predefined set of functions that are performed exclusively through a touch screen and/or a touchpad optionally



US 11,106,352 B2

21

include navigation between user interfaces. In some embodiments, the touchpad, when touched by the user, navigates device 100 to a main, home, or root menu from any user interface that is displayed on device 100. In such embodiments, a "menu button" is implemented using a touchpad. In some other embodiments, the menu button is a physical push button or other physical input control device instead of a touchpad.

FIG. 1B is a block diagram illustrating example components for event handling in accordance with some embodiments. In some embodiments, memory 102 (in FIG. 1A) or 370 (FIG. 3) includes event sorter 170 (e.g., in operating system 126) and a respective application 136-1 (e.g., any of the aforementioned applications 136, 137-155, 380-390).

Event sorter 170 receives event information and determines the application 136-1 and application view 191 of application 136-1 to which to deliver the event information. Event sorter 170 includes event monitor 171 and event dispatcher module 174. In some embodiments, application 136-1 includes application internal state 192, which indicates the current application view(s) displayed on touch-sensitive display system 112 when the application is active or executing. In some embodiments, device/global internal state 157 is used by event sorter 170 to determine which application(s) is (are) currently active, and application internal state 192 is used by event sorter 170 to determine application views 191 to which to deliver event information.

In some embodiments, application internal state 192 includes additional information, such as one or more of: resume information to be used when application 136-1 resumes execution, user interface state information that indicates information being displayed or that is ready for display by application 136-1, a state queue for enabling the user to go back to a prior state or view of application 136-1, and a redo/undo queue of previous actions taken by the user.

Event monitor 171 receives event information from peripherals interface 118. Event information includes information about a sub-event (e.g., a user touch on touch-sensitive display system 112, as part of a multi-touch gesture). Peripherals interface 118 transmits information it receives from I/O subsystem 106 or a sensor, such as proximity sensor 166, accelerometer(s) 168, and/or microphone 113 (through audio circuitry 110). Information that peripherals interface 118 receives from I/O subsystem 106 includes information from touch-sensitive display system 112 or a touch-sensitive surface.

In some embodiments, event monitor 171 sends requests to the peripherals interface 118 at predetermined intervals. In response, peripherals interface 118 transmits event information. In other embodiments, peripheral interface 118 transmits event information only when there is a significant event (e.g., receiving an input above a predetermined noise threshold and/or for more than a predetermined duration).

In some embodiments, event sorter 170 also includes a hit view determination module 172 and/or an active event recognizer determination module 173.

Hit view determination module 172 provides software procedures for determining where a sub-event has taken place within one or more views, when touch-sensitive display system 112 displays more than one view. Views are made up of controls and other elements that a user can see on the display.

Another aspect of the user interface associated with an application is a set of views, sometimes herein called application views or user interface windows, in which information is displayed and touch-based gestures occur. The application views (of a respective application) in which

22

a touch is detected optionally correspond to programmatic levels within a programmatic or view hierarchy of the application. For example, the lowest level view in which a touch is detected is, optionally, called the hit view, and the set of events that are recognized as proper inputs are, optionally, determined based, at least in part, on the hit view of the initial touch that begins a touch-based gesture.

Hit view determination module 172 receives information related to sub-events of a touch-based gesture. When an application has multiple views organized in a hierarchy, hit view determination module 172 identifies a hit view as the lowest view in the hierarchy which should handle the sub-event. In most circumstances, the hit view is the lowest level view in which an initiating sub-event occurs (i.e., the first sub-event in the sequence of sub-events that form an event or potential event). Once the hit view is identified by the hit view determination module, the hit view typically receives all sub-events related to the same touch or input source for which it was identified as the hit view.

Active event recognizer determination module 173 determines which view or views within a view hierarchy should receive a particular sequence of sub-events. In some embodiments, active event recognizer determination module 173 determines that only the hit view should receive a particular sequence of sub-events. In other embodiments, active event recognizer determination module 173 determines that all views that include the physical location of a sub-event are actively involved views, and therefore determines that all actively involved views should receive a particular sequence of sub-events. In other embodiments, even if touch sub-events were entirely confined to the area associated with one particular view, views higher in the hierarchy would still remain as actively involved views.

Event dispatcher module 174 dispatches the event information to an event recognizer (e.g., event recognizer 180). In embodiments including active event recognizer determination module 173, event dispatcher module 174 delivers the event information to an event recognizer determined by active event recognizer determination module 173. In some embodiments, event dispatcher module 174 stores in an event queue the event information, which is retrieved by a respective event receiver module 182.

In some embodiments, operating system 126 includes event sorter 170. Alternatively, application 136-1 includes event sorter 170. In yet other embodiments, event sorter 170 is a stand-alone module, or a part of another module stored in memory 102, such as contact/motion module 130.

In some embodiments, application 136-1 includes a plurality of event handlers 190 and one or more application views 191, each of which includes instructions for handling touch events that occur within a respective view of the application's user interface. Each application view 191 of the application 136-1 includes one or more event recognizers 180. Typically, a respective application view 191 includes a plurality of event recognizers 180. In other embodiments, one or more of event recognizers 180 are part of a separate module, such as a user interface kit (not shown) or a higher level object from which application 136-1 inherits methods and other properties. In some embodiments, a respective event handler 190 includes one or more of: data updater 176, object updater 177, GUI updater 178, and/or event data 179 received from event sorter 170. Event handler 190 optionally utilizes or calls data updater 176, object updater 177 or GUI updater 178 to update the application internal state 192. Alternatively, one or more of the application views 191 includes one or more respective event handlers 190. Also, in some embodiments, one or

US 11,106,352 B2

23

more of data updater 176, object updater 177, and GUI updater 178 are included in a respective application view 191.

A respective event recognizer 180 receives event information (e.g., event data 179) from event sorter 170, and identifies an event from the event information. Event recognizer 180 includes event receiver 182 and event comparator 184. In some embodiments, event recognizer 180 also includes at least a subset of: metadata 183, and event delivery instructions 188 (which optionally include sub-event delivery instructions).

Event receiver 182 receives event information from event sorter 170. The event information includes information about a sub-event, for example, a touch or a touch movement. Depending on the sub-event, the event information also includes additional information, such as location of the sub-event. When the sub-event concerns motion of a touch, the event information optionally also includes speed and direction of the sub-event. In some embodiments, events include rotation of the device from one orientation to another (e.g., from a portrait orientation to a landscape orientation, or vice versa), and the event information includes corresponding information about the current orientation (also called device attitude) of the device.

Event comparator 184 compares the event information to predefined event or sub-event definitions and, based on the comparison, determines an event or sub-event, or determines or updates the state of an event or sub-event. In some embodiments, event comparator 184 includes event definitions 186. Event definitions 186 contain definitions of events (e.g., predefined sequences of sub-events), for example, event 1 (187-1), event 2 (187-2), and others. In some embodiments, sub-events in an event 187 include, for example, touch begin, touch end, touch movement, touch cancellation, and multiple touching. In one example, the definition for event 1 (187-1) is a double tap on a displayed object. The double tap, for example, comprises a first touch (touch begin) on the displayed object for a predetermined phase, a first lift-off (touch end) for a predetermined phase, a second touch (touch begin) on the displayed object for a predetermined phase, and a second lift-off (touch end) for a predetermined phase. In another example, the definition for event 2 (187-2) is a dragging on a displayed object. The dragging, for example, comprises a touch (or contact) on the displayed object for a predetermined phase, a movement of the touch across touch-sensitive display system 112, and lift-off of the touch (touch end). In some embodiments, the event also includes information for one or more associated event handlers 190.

In some embodiments, event definition 187 includes a definition of an event for a respective user-interface object. In some embodiments, event comparator 184 performs a hit test to determine which user-interface object is associated with a sub-event. For example, in an application view in which three user-interface objects are displayed on touch-sensitive display system 112, when a touch is detected on touch-sensitive display system 112, event comparator 184 performs a hit test to determine which of the three user-interface objects is associated with the touch (sub-event). If each displayed object is associated with a respective event handler 190, the event comparator uses the result of the hit test to determine which event handler 190 should be activated. For example, event comparator 184 selects an event handler associated with the sub-event and the object triggering the hit test.

In some embodiments, the definition for a respective event 187 also includes delayed actions that delay delivery

24

of the event information until after it has been determined whether the sequence of sub-events does or does not correspond to the event recognizer's event type.

When a respective event recognizer 180 determines that the series of sub-events do not match any of the events in event definitions 186, the respective event recognizer 180 enters an event impossible, event failed, or event ended state, after which it disregards subsequent sub-events of the touch-based gesture. In this situation, other event recognizers, if any, that remain active for the hit view continue to track and process sub-events of an ongoing touch-based gesture.

In some embodiments, a respective event recognizer 180 includes metadata 183 with configurable properties, flags, and/or lists that indicate how the event delivery system should perform sub-event delivery to actively involved event recognizers. In some embodiments, metadata 183 includes configurable properties, flags, and/or lists that indicate how event recognizers interact, or are enabled to interact, with one another. In some embodiments, metadata 183 includes configurable properties, flags, and/or lists that indicate whether sub-events are delivered to varying levels in the view or programmatic hierarchy.

In some embodiments, a respective event recognizer 180 activates event handler 190 associated with an event when one or more particular sub-events of an event are recognized. In some embodiments, a respective event recognizer 180 delivers event information associated with the event to event handler 190. Activating an event handler 190 is distinct from sending (and deferred sending) sub-events to a respective hit view. In some embodiments, event recognizer 180 throws a flag associated with the recognized event, and event handler 190 associated with the flag catches the flag and performs a predefined process.

In some embodiments, event delivery instructions 188 include sub-event delivery instructions that deliver event information about a sub-event without activating an event handler. Instead, the sub-event delivery instructions deliver event information to event handlers associated with the series of sub-events or to actively involved views. Event handlers associated with the series of sub-events or with actively involved views receive the event information and perform a predetermined process.

In some embodiments, data updater 176 creates and updates data used in application 136-1. For example, data updater 176 updates the telephone number used in contacts module 137, or stores a video file used in video and music player module 152. In some embodiments, object updater 177 creates and updates objects used in application 136-1. For example, object updater 177 creates a new user-interface object or updates the position of a user-interface object. GUI updater 178 updates the GUI. For example, GUI updater 178 prepares display information and sends it to graphics module 132 for display on a touch-sensitive display.

In some embodiments, event handler(s) 190 includes or has access to data updater 176, object updater 177, and GUI updater 178. In some embodiments, data updater 176, object updater 177, and GUI updater 178 are included in a single module of a respective application 136-1 or application view 191. In other embodiments, they are included in two or more software modules.

It shall be understood that the foregoing discussion regarding event handling of user touches on touch-sensitive displays also applies to other forms of user inputs to operate multifunction devices 100 with input-devices, not all of which are initiated on touch screens. For example, mouse movement and mouse button presses, optionally coordinated



## US 11,106,352 B2

25

with single or multiple keyboard presses or holds; contact movements such as taps, drags, scrolls, etc., on touch-pads; pen stylus inputs; movement of the device; oral instructions; detected eye movements; biometric inputs; and/or any combination thereof are optionally utilized as inputs corresponding to sub-events which define an event to be recognized.

FIG. 1C is a block diagram illustrating a tactile output module in accordance with some embodiments. In some embodiments, I/O subsystem 106 (e.g., haptic feedback controller 161 (FIG. 1A) and/or other input controller(s) 160 (FIG. 1A)) includes at least some of the example components shown in FIG. 1C. In some embodiments, peripherals interface 118 includes at least some of the example components shown in FIG. 1C.

In some embodiments, the tactile output module includes haptic feedback module 133. In some embodiments, haptic feedback module 133 aggregates and combines tactile outputs for user interface feedback from software applications on the electronic device (e.g., feedback that is responsive to user inputs that correspond to displayed user interfaces and alerts and other notifications that indicate the performance of operations or occurrence of events in user interfaces of the electronic device). Haptic feedback module 133 includes one or more of: waveform module 123 (for providing waveforms used for generating tactile outputs), mixer 125 (for mixing waveforms, such as waveforms in different channels), compressor 127 (for reducing or compressing a dynamic range of the waveforms), low-pass filter 129 (for filtering out high frequency signal components in the waveforms), and thermal controller 131 (for adjusting the waveforms in accordance with thermal conditions). In some embodiments, haptic feedback module 133 is included in haptic feedback controller 161 (FIG. 1A). In some embodiments, a separate unit of haptic feedback module 133 (or a separate implementation of haptic feedback module 133) is also included in an audio controller (e.g., audio circuitry 110, FIG. 1A) and used for generating audio signals. In some embodiments, a single haptic feedback module 133 is used for generating audio signals and generating waveforms for tactile outputs.

In some embodiments, haptic feedback module 133 also includes trigger module 121 (e.g., a software application, operating system, or other software module that determines a tactile output is to be generated and initiates the process for generating the corresponding tactile output). In some embodiments, trigger module 121 generates trigger signals for initiating generation of waveforms (e.g., by waveform module 123). For example, trigger module 121 generates trigger signals based on preset timing criteria. In some embodiments, trigger module 121 receives trigger signals from outside haptic feedback module 133 (e.g., in some embodiments, haptic feedback module 133 receives trigger signals from hardware input processing module 146 located outside haptic feedback module 133) and relays the trigger signals to other components within haptic feedback module 133 (e.g., waveform module 123) or software applications that trigger operations (e.g., with trigger module 121) based on activation of a user interface element (e.g., an application icon or an affordance within an application) or a hardware input device (e.g., a home button or an intensity-sensitive input surface, such as an intensity-sensitive touch screen). In some embodiments, trigger module 121 also receives tactile feedback generation instructions (e.g., from haptic feedback module 133, FIGS. 1A and 3). In some embodiments, trigger module 121 generates trigger signals in response to haptic feedback module 133 (or trigger module 121 in haptic

26

feedback module 133) receiving tactile feedback instructions (e.g., from haptic feedback module 133, FIGS. 1A and 3).

Waveform module 123 receives trigger signals (e.g., from trigger module 121) as an input, and in response to receiving trigger signals, provides waveforms for generation of one or more tactile outputs (e.g., waveforms selected from a pre-defined set of waveforms designated for use by waveform module 123, such as the waveforms described in greater detail below with reference to FIGS. 4F-4G).

Mixer 125 receives waveforms (e.g., from waveform module 123) as an input, and mixes together the waveforms. For example, when mixer 125 receives two or more waveforms (e.g., a first waveform in a first channel and a second waveform that at least partially overlaps with the first waveform in a second channel) mixer 125 outputs a combined waveform that corresponds to a sum of the two or more waveforms. In some embodiments, mixer 125 also modifies one or more waveforms of the two or more waveforms to emphasize particular waveform(s) over the rest of the two or more waveforms (e.g., by increasing a scale of the particular waveform(s) and/or decreasing a scale of the rest of the waveforms). In some circumstances, mixer 125 selects one or more waveforms to remove from the combined waveform (e.g., the waveform from the oldest source is dropped when there are waveforms from more than three sources that have been requested to be output concurrently by tactile output generator 167).

Compressor 127 receives waveforms (e.g., a combined waveform from mixer 125) as an input, and modifies the waveforms. In some embodiments, compressor 127 reduces the waveforms (e.g., in accordance with physical specifications of tactile output generators 167 (FIG. 1A) or 357 (FIG. 3)) so that tactile outputs corresponding to the waveforms are reduced. In some embodiments, compressor 127 limits the waveforms, such as by enforcing a predefined maximum amplitude for the waveforms. For example, compressor 127 reduces amplitudes of portions of waveforms that exceed a predefined amplitude threshold while maintaining amplitudes of portions of waveforms that do not exceed the predefined amplitude threshold. In some embodiments, compressor 127 reduces a dynamic range of the waveforms. In some embodiments, compressor 127 dynamically reduces the dynamic range of the waveforms so that the combined waveforms remain within performance specifications of the tactile output generator 167 (e.g., force and/or moveable mass displacement limits).

Low-pass filter 129 receives waveforms (e.g., compressed waveforms from compressor 127) as an input, and filters (e.g., smooths) the waveforms (e.g., removes or reduces high frequency signal components in the waveforms). For example, in some instances, compressor 127 includes, in compressed waveforms, extraneous signals (e.g., high frequency signal components) that interfere with the generation of tactile outputs and/or exceed performance specifications of tactile output generator 167 when the tactile outputs are generated in accordance with the compressed waveforms. Low-pass filter 129 reduces or removes such extraneous signals in the waveforms.

Thermal controller 131 receives waveforms (e.g., filtered waveforms from low-pass filter 129) as an input, and adjusts the waveforms in accordance with thermal conditions of device 100 (e.g., based on internal temperatures detected within device 100, such as the temperature of haptic feedback controller 161, and/or external temperatures detected by device 100). For example, in some cases, the output of haptic feedback controller 161 varies depending on the

temperature (e.g., haptic feedback controller 161, in response to receiving same waveforms, generates a first tactile output when haptic feedback controller 161 is at a first temperature and generates a second tactile output when haptic feedback controller 161 is at a second temperature that is distinct from the first temperature). For example, the magnitude (or the amplitude) of the tactile outputs may vary depending on the temperature. To reduce the effect of the temperature variations, the waveforms are modified (e.g., an amplitude of the waveforms is increased or decreased based on the temperature).

In some embodiments, haptic feedback module 133 (e.g., trigger module 121) is coupled to hardware input processing module 146. In some embodiments, other input controller(s) 160 in FIG. 1A includes hardware input processing module 146. In some embodiments, hardware input processing module 146 receives inputs from hardware input device 145 (e.g., other input or control devices 116 in FIG. 1A, such as a home button or an intensity-sensitive input surface, such as an intensity-sensitive touch screen). In some embodiments, hardware input device 145 is any input device described herein, such as touch-sensitive display system 112 (FIG. 1A), keyboard/mouse 350 (FIG. 3), touchpad 355 (FIG. 3), one of other input or control devices 116 (FIG. 1A), or an intensity-sensitive home button. In some embodiments, hardware input device 145 consists of an intensity-sensitive home button, and not touch-sensitive display system 112 (FIG. 1A), keyboard/mouse 350 (FIG. 3), or touchpad 355 (FIG. 3). In some embodiments, in response to inputs from hardware input device 145 (e.g., an intensity-sensitive home button or a touch screen), hardware input processing module 146 provides one or more trigger signals to haptic feedback module 133 to indicate that a user input satisfying predefined input criteria, such as an input corresponding to a “click” of a home button (e.g., a “down click” or an “up click”), has been detected. In some embodiments, haptic feedback module 133 provides waveforms that correspond to the “click” of a home button in response to the input corresponding to the “click” of a home button, simulating a haptic feedback of pressing a physical home button.

In some embodiments, the tactile output module includes haptic feedback controller 161 (e.g., haptic feedback controller 161 in FIG. 1A), which controls the generation of tactile outputs. In some embodiments, haptic feedback controller 161 is coupled to a plurality of tactile output generators, and selects one or more tactile output generators of the plurality of tactile output generators and sends waveforms to the selected one or more tactile output generators for generating tactile outputs. In some embodiments, haptic feedback controller 161 coordinates tactile output requests that correspond to activation of hardware input device 145 and tactile output requests that correspond to software events (e.g., tactile output requests from haptic feedback module 133) and modifies one or more waveforms of the two or more waveforms to emphasize particular waveform(s) over the rest of the two or more waveforms (e.g., by increasing a scale of the particular waveform(s) and/or decreasing a scale of the rest of the waveforms, such as to prioritize tactile outputs that correspond to activations of hardware input device 145 over tactile outputs that correspond to software events).

In some embodiments, as shown in FIG. 1C, an output of haptic feedback controller 161 is coupled to audio circuitry of device 100 (e.g., audio circuitry 110, FIG. 1A), and provides audio signals to audio circuitry of device 100. In some embodiments, haptic feedback controller 161 provides both waveforms used for generating tactile outputs and

audio signals used for providing audio outputs in conjunction with generation of the tactile outputs. In some embodiments, haptic feedback controller 161 modifies audio signals and/or waveforms (used for generating tactile outputs) so that the audio outputs and the tactile outputs are synchronized (e.g., by delaying the audio signals and/or waveforms). In some embodiments, haptic feedback controller 161 includes a digital-to-analog converter used for converting digital waveforms into analog signals, which are received by amplifier 163 and/or tactile output generator 167.

In some embodiments, the tactile output module includes amplifier 163. In some embodiments, amplifier 163 receives waveforms (e.g., from haptic feedback controller 161) and amplifies the waveforms prior to sending the amplified waveforms to tactile output generator 167 (e.g., any of tactile output generators 167 (FIG. 1A) or 357 (FIG. 3)). For example, amplifier 163 amplifies the received waveforms to signal levels that are in accordance with physical specifications of tactile output generator 167 (e.g., to a voltage and/or a current required by tactile output generator 167 for generating tactile outputs so that the signals sent to tactile output generator 167 produce tactile outputs that correspond to the waveforms received from haptic feedback controller 161) and sends the amplified waveforms to tactile output generator 167. In response, tactile output generator 167 generates tactile outputs (e.g., by shifting a moveable mass back and forth in one or more dimensions relative to a neutral position of the moveable mass).

In some embodiments, the tactile output module includes sensor 169, which is coupled to tactile output generator 167. Sensor 169 detects states or state changes (e.g., mechanical position, physical displacement, and/or movement) of tactile output generator 167 or one or more components of tactile output generator 167 (e.g., one or more moving parts, such as a membrane, used to generate tactile outputs). In some embodiments, sensor 169 is a magnetic field sensor (e.g., a Hall effect sensor) or other displacement and/or movement sensor. In some embodiments, sensor 169 provides information (e.g., a position, a displacement, and/or a movement of one or more parts in tactile output generator 167) to haptic feedback controller 161 and, in accordance with the information provided by sensor 169 about the state of tactile output generator 167, haptic feedback controller 161 adjusts the waveforms output from haptic feedback controller 161 (e.g., waveforms sent to tactile output generator 167, optionally via amplifier 163).

FIG. 2 illustrates a portable multifunction device 100 having a touch screen (e.g., touch-sensitive display system 112, FIG. 1A) in accordance with some embodiments. The touch screen optionally displays one or more graphics within user interface (UI) 200. In these embodiments, as well as others described below, a user is enabled to select one or more of the graphics by making a gesture on the graphics, for example, with one or more fingers 202 (not drawn to scale in the figure) or one or more styluses 203 (not drawn to scale in the figure). In some embodiments, selection of one or more graphics occurs when the user breaks contact with the one or more graphics. In some embodiments, the gesture optionally includes one or more taps, one or more swipes (from left to right, right to left, upward and/or downward) and/or a rolling of a finger (from right to left, left to right, upward and/or downward) that has made contact with device 100. In some implementations or circumstances, inadvertent contact with a graphic does not select the graphic. For example, a swipe gesture that sweeps over an



US 11,106,352 B2

29

application icon optionally does not select the corresponding application when the gesture corresponding to selection is a tap.

Device 100 optionally also includes one or more physical buttons, such as "home" or menu button 204. As described previously, menu button 204 is, optionally, used to navigate to any application 136 in a set of applications that are, optionally executed on device 100. Alternatively, in some embodiments, the menu button is implemented as a soft key in a GUI displayed on the touch-screen display.

In some embodiments, device 100 includes the touch-screen display, menu button 204 (sometimes called home button 204), push button 206 for powering the device on/off and locking the device, volume adjustment button(s) 208, Subscriber Identity Module (SIM) card slot 210, head set jack 212, and docking/charging external port 124. Push button 206 is, optionally, used to turn the power on/off on the device by depressing the button and holding the button in the depressed state for a predefined time interval; to lock the device by depressing the button and releasing the button before the predefined time interval has elapsed; and/or to unlock the device or initiate an unlock process. In some embodiments, device 100 also accepts verbal input for activation or deactivation of some functions through microphone 113. Device 100 also, optionally, includes one or more contact intensity sensors 165 for detecting intensities of contacts on touch-sensitive display system 112 and/or one or more tactile output generators 167 for generating tactile outputs for a user of device 100.

FIG. 3 is a block diagram of an example multifunction device with a display and a touch-sensitive surface in accordance with some embodiments. Device 300 need not be portable. In some embodiments, device 300 is a laptop computer, a desktop computer, a tablet computer, a multimedia player device, a navigation device, an educational device (such as a child's learning toy), a gaming system, or a control device (e.g., a home or industrial controller). Device 300 typically includes one or more processing units (CPU's) 310, one or more network or other communications interfaces 360, memory 370, and one or more communication buses 320 for interconnecting these components. Communication buses 320 optionally include circuitry (sometimes called a chipset) that interconnects and controls communications between system components. Device 300 includes input/output (I/O) interface 330 comprising display 340, which is typically a touch-screen display. I/O interface 330 also optionally includes a keyboard and/or mouse (or other pointing device) 350 and touchpad 355, tactile output generator 357 for generating tactile outputs on device 300 (e.g., similar to tactile output generator(s) 167 described above with reference to FIG. 1A), sensors 359 (e.g., optical, acceleration, proximity, touch-sensitive, and/or contact intensity sensors similar to contact intensity sensor(s) 165 described above with reference to FIG. 1A). Memory 370 includes high-speed random access memory, such as DRAM, SRAM, DDR RAM or other random access solid state memory devices; and optionally includes non-volatile memory, such as one or more magnetic disk storage devices, optical disk storage devices, flash memory devices, or other non-volatile solid state storage devices. Memory 370 optionally includes one or more storage devices remotely located from CPU(s) 310. In some embodiments, memory 370 stores programs, modules, and data structures analogous to the programs, modules, and data structures stored in memory 102 of portable multifunction device 100 (FIG. 1A), or a subset thereof. Furthermore, memory 370 optionally stores additional programs, modules, and data structures

30

not present in memory 102 of portable multifunction device 100. For example, memory 370 of device 300 optionally stores drawing module 380, presentation module 382, word processing module 384, website creation module 386, disk authoring module 388, and/or spreadsheet module 390, while memory 102 of portable multifunction device 100 (FIG. 1A) optionally does not store these modules.

Each of the above identified elements in FIG. 3 are, optionally, stored in one or more of the previously mentioned memory devices. Each of the above identified modules corresponds to a set of instructions for performing a function described above. The above identified modules or programs (i.e., sets of instructions) need not be implemented as separate software programs, procedures or modules, and thus various subsets of these modules are, optionally, combined or otherwise re-arranged in various embodiments. In some embodiments, memory 370 optionally stores a subset of the modules and data structures identified above. Furthermore, memory 370 optionally stores additional modules and data structures not described above.

Attention is now directed towards embodiments of user interfaces ("UI") that are, optionally, implemented on portable multifunction device 100.

FIG. 4A illustrates an example user interface for a menu of applications on portable multifunction device 100 in accordance with some embodiments. Similar user interfaces are, optionally, implemented on device 300. In some embodiments, user interface 400 includes the following elements, or a subset or superset thereof:

- Signal strength indicator(s) for wireless communication(s), such as cellular and Wi-Fi signals;
- Time;
- a Bluetooth indicator;
- a Battery status indicator;
- Tray 408 with icons for frequently used applications, such as:
  - Icon 416 for telephone module 138, labeled "Phone," which optionally includes an indicator 414 of the number of missed calls or voicemail messages;
  - Icon 418 for e-mail client module 140, labeled "Mail," which optionally includes an indicator 410 of the number of unread e-mails;
  - Icon 420 for browser module 147, labeled "Browser;" and
  - Icon 422 for video and music player module 152, labeled "Music;" and
- Icons for other applications, such as:
  - Icon 424 for IM module 141, labeled "Messages;"
  - Icon 426 for calendar module 148, labeled "Calendar;"
  - Icon 428 for image management module 144, labeled "Photos;"
  - Icon 430 for camera module 143, labeled "Camera;"
  - Icon 432 for online video module 155, labeled "Online Video;"
  - Icon 434 for stocks mini application 149-2, labeled "Stocks;"
  - Icon 436 for map module 154, labeled "Maps;"
  - Icon 438 for weather mini application 149-1, labeled "Weather;"
  - Icon 440 for alarm clock mini application 149-4, labeled "Clock;"
  - Icon 442 for workout support module 142, labeled "Workout Support;"
  - Icon 444 for notes module 153, labeled "Notes;" and
  - Icon 446 for a settings application or module, which provides access to settings for device 100 and its various applications 136.

US 11,106,352 B2

31

It should be noted that the icon labels illustrated in FIG. 4A are merely examples. For example, other labels are, optionally, used for various application icons. In some embodiments, a label for a respective application icon includes a name of an application corresponding to the respective application icon. In some embodiments, a label for a particular application icon is distinct from a name of an application corresponding to the particular application icon.

FIG. 4B illustrates an example user interface on a device (e.g., device 300, FIG. 3) with a touch-sensitive surface 451 (e.g., a tablet or touchpad 355, FIG. 3) that is separate from the display 450. Although many of the examples that follow will be given with reference to inputs on touch screen display 112 (where the touch sensitive surface and the display are combined), in some embodiments, the device detects inputs on a touch-sensitive surface that is separate from the display, as shown in FIG. 4B. In some embodiments, the touch-sensitive surface (e.g., 451 in FIG. 4B) has a primary axis (e.g., 452 in FIG. 4B) that corresponds to a primary axis (e.g., 453 in FIG. 4B) on the display (e.g., 450). In accordance with these embodiments, the device detects contacts (e.g., 460 and 462 in FIG. 4B) with the touch-sensitive surface 451 at locations that correspond to respective locations on the display (e.g., in FIG. 4B, 460 corresponds to 468 and 462 corresponds to 470). In this way, user inputs (e.g., contacts 460 and 462, and movements thereof) detected by the device on the touch-sensitive surface (e.g., 451 in FIG. 4B) are used by the device to manipulate the user interface on the display (e.g., 450 in FIG. 4B) of the multifunction device when the touch-sensitive surface is separate from the display. It should be understood that similar methods are, optionally, used for other user interfaces described herein.

Additionally, while the following examples are given primarily with reference to finger inputs (e.g., finger contacts, finger tap gestures, finger swipe gestures, etc.), it should be understood that, in some embodiments, one or more of the finger inputs are replaced with input from another input device (e.g., a mouse based input or a stylus input). For example, a swipe gesture is, optionally, replaced with a mouse click (e.g., instead of a contact) followed by movement of the cursor along the path of the swipe (e.g., instead of movement of the contact). As another example, a tap gesture is, optionally, replaced with a mouse click while the cursor is located over the location of the tap gesture (e.g., instead of detection of the contact followed by ceasing to detect the contact). Similarly, when multiple user inputs are simultaneously detected, it should be understood that multiple computer mice are, optionally, used simultaneously, or a mouse and finger contacts are, optionally, used simultaneously.

As used herein, the term “focus selector” refers to an input element that indicates a current part of a user interface with which a user is interacting. In some implementations that include a cursor or other location marker, the cursor acts as a “focus selector,” so that when an input (e.g., a press input) is detected on a touch-sensitive surface (e.g., touchpad 355 in FIG. 3 or touch-sensitive surface 451 in FIG. 4B) while the cursor is over a particular user interface element (e.g., a button, window, slider or other user interface element), the particular user interface element is adjusted in accordance with the detected input. In some implementations that include a touch-screen display (e.g., touch-sensitive display system 112 in FIG. 1A or the touch screen in FIG. 4A) that enables direct interaction with user interface elements on the touch-screen display, a detected contact on the touch-screen acts as a “focus selector,” so that when an input (e.g., a press

32

input by the contact) is detected on the touch-screen display at a location of a particular user interface element (e.g., a button, window, slider or other user interface element), the particular user interface element is adjusted in accordance with the detected input. In some implementations, focus is moved from one region of a user interface to another region of the user interface without corresponding movement of a cursor or movement of a contact on a touch-screen display (e.g., by using a tab key or arrow keys to move focus from one button to another button); in these implementations, the focus selector moves in accordance with movement of focus between different regions of the user interface. Without regard to the specific form taken by the focus selector, the focus selector is generally the user interface element (or contact on a touch-screen display) that is controlled by the user so as to communicate the user's intended interaction with the user interface (e.g., by indicating, to the device, the element of the user interface with which the user is intending to interact). For example, the location of a focus selector (e.g., a cursor, a contact, or a selection box) over a respective button while a press input is detected on the touch-sensitive surface (e.g., a touchpad or touch screen) will indicate that the user is intending to activate the respective button (as opposed to other user interface elements shown on a display of the device).

As used in the specification and claims, the term “intensity” of a contact on a touch-sensitive surface refers to the force or pressure (force per unit area) of a contact (e.g., a finger contact or a stylus contact) on the touch-sensitive surface, or to a substitute (proxy) for the force or pressure of a contact on the touch-sensitive surface. The intensity of a contact has a range of values that includes at least four distinct values and more typically includes hundreds of distinct values (e.g., at least 256). Intensity of a contact is, optionally, determined (or measured) using various approaches and various sensors or combinations of sensors. For example, one or more force sensors underneath or adjacent to the touch-sensitive surface are, optionally, used to measure force at various points on the touch-sensitive surface. In some implementations, force measurements from multiple force sensors are combined (e.g., a weighted average or a sum) to determine an estimated force of a contact. Similarly, a pressure-sensitive tip of a stylus is, optionally, used to determine a pressure of the stylus on the touch-sensitive surface. Alternatively, the size of the contact area detected on the touch-sensitive surface and/or changes thereto, the capacitance of the touch-sensitive surface proximate to the contact and/or changes thereto, and/or the resistance of the touch-sensitive surface proximate to the contact and/or changes thereto are, optionally, used as a substitute for the force or pressure of the contact on the touch-sensitive surface. In some implementations, the substitute measurements for contact force or pressure are used directly to determine whether an intensity threshold has been exceeded (e.g., the intensity threshold is described in units corresponding to the substitute measurements). In some implementations, the substitute measurements for contact force or pressure are converted to an estimated force or pressure and the estimated force or pressure is used to determine whether an intensity threshold has been exceeded (e.g., the intensity threshold is a pressure threshold measured in units of pressure). Using the intensity of a contact as an attribute of a user input allows for user access to additional device functionality that may otherwise not be readily accessible by the user on a reduced-size device with limited real estate for displaying affordances (e.g., on a touch-sensitive display) and/or receiving user input (e.g., via



US 11,106,352 B2

33

a touch-sensitive display, a touch-sensitive surface, or a physical/mechanical control such as a knob or a button).

In some embodiments, contact/motion module 130 uses a set of one or more intensity thresholds to determine whether an operation has been performed by a user (e.g., to determine whether a user has “clicked” on an icon). In some embodiments, at least a subset of the intensity thresholds are determined in accordance with software parameters (e.g., the intensity thresholds are not determined by the activation thresholds of particular physical actuators and can be adjusted without changing the physical hardware of device 100). For example, a mouse “click” threshold of a trackpad or touch-screen display can be set to any of a large range of predefined thresholds values without changing the trackpad or touch-screen display hardware. Additionally, in some implementations a user of the device is provided with software settings for adjusting one or more of the set of intensity thresholds (e.g., by adjusting individual intensity thresholds and/or by adjusting a plurality of intensity thresholds at once with a system-level click “intensity” parameter).

As used in the specification and claims, the term “characteristic intensity” of a contact refers to a characteristic of the contact based on one or more intensities of the contact. In some embodiments, the characteristic intensity is based on multiple intensity samples. The characteristic intensity is, optionally, based on a predefined number of intensity samples, or a set of intensity samples collected during a predetermined time period (e.g., 0.05, 0.1, 0.2, 0.5, 1, 2, 5, 10 seconds) relative to a predefined event (e.g., after detecting the contact, prior to detecting liftoff of the contact, before or after detecting a start of movement of the contact, prior to detecting an end of the contact, before or after detecting an increase in intensity of the contact, and/or before or after detecting a decrease in intensity of the contact). A characteristic intensity of a contact is, optionally based on one or more of: a maximum value of the intensities of the contact, a mean value of the intensities of the contact, an average value of the intensities of the contact, a top 10 percentile value of the intensities of the contact, a value at the half maximum of the intensities of the contact, a value at the 90 percent maximum of the intensities of the contact, a value produced by low-pass filtering the intensity of the contact over a predefined period or starting at a predefined time, or the like. In some embodiments, the duration of the contact is used in determining the characteristic intensity (e.g., when the characteristic intensity is an average of the intensity of the contact over time). In some embodiments, the characteristic intensity is compared to a set of one or more intensity thresholds to determine whether an operation has been performed by a user. For example, the set of one or more intensity thresholds may include a first intensity threshold and a second intensity threshold. In this example, a contact with a characteristic intensity that does not exceed the first intensity threshold results in a first operation, a contact with a characteristic intensity that exceeds the first intensity threshold and does not exceed the second intensity threshold results in a second operation, and a contact with a characteristic intensity that exceeds the second intensity threshold results in a third operation. In some embodiments, a comparison between the characteristic intensity and one or more intensity thresholds is used to determine whether or not to perform one or more operations (e.g., whether to perform a respective option or forgo performing the respective operation) rather than being used to determine whether to perform a first operation or a second operation.

In some embodiments, a portion of a gesture is identified for purposes of determining a characteristic intensity. For

34

example, a touch-sensitive surface may receive a continuous swipe contact transitioning from a start location and reaching an end location (e.g., a drag gesture), at which point the intensity of the contact increases. In this example, the characteristic intensity of the contact at the end location may be based on only a portion of the continuous swipe contact, and not the entire swipe contact (e.g., only the portion of the swipe contact at the end location). In some embodiments, a smoothing algorithm may be applied to the intensities of the swipe contact prior to determining the characteristic intensity of the contact. For example, the smoothing algorithm optionally includes one or more of: an unweighted sliding-average smoothing algorithm, a triangular smoothing algorithm, a median filter smoothing algorithm, and/or an exponential smoothing algorithm. In some circumstances, these smoothing algorithms eliminate narrow spikes or dips in the intensities of the swipe contact for purposes of determining a characteristic intensity.

The user interface figures described herein optionally include various intensity diagrams that show the current intensity of the contact on the touch-sensitive surface relative to one or more intensity thresholds (e.g., a contact detection intensity threshold  $IT_D$ , a light press intensity threshold  $IT_L$ , a deep press intensity threshold  $IT_D$  (e.g., that is at least initially higher than  $IT_L$ ), and/or one or more other intensity thresholds (e.g., an intensity threshold  $IT_H$  that is lower than  $IT_L$ )). This intensity diagram is typically not part of the displayed user interface, but is provided to aid in the interpretation of the figures. In some embodiments, the light press intensity threshold corresponds to an intensity at which the device will perform operations typically associated with clicking a button of a physical mouse or a trackpad. In some embodiments, the deep press intensity threshold corresponds to an intensity at which the device will perform operations that are different from operations typically associated with clicking a button of a physical mouse or a trackpad. In some embodiments, when a contact is detected with a characteristic intensity below the light press intensity threshold (e.g., and above a nominal contact-detection intensity threshold  $IT_0$  below which the contact is no longer detected), the device will move a focus selector in accordance with movement of the contact on the touch-sensitive surface without performing an operation associated with the light press intensity threshold or the deep press intensity threshold. Generally, unless otherwise stated, these intensity thresholds are consistent between different sets of user interface figures.

In some embodiments, the response of the device to inputs detected by the device depends on criteria based on the contact intensity during the input. For example, for some “light press” inputs, the intensity of a contact exceeding a first intensity threshold during the input triggers a first response. In some embodiments, the response of the device to inputs detected by the device depends on criteria that include both the contact intensity during the input and time-based criteria. For example, for some “deep press” inputs, the intensity of a contact exceeding a second intensity threshold during the input, greater than the first intensity threshold for a light press, triggers a second response only if a delay time has elapsed between meeting the first intensity threshold and meeting the second intensity threshold. This delay time is typically less than 200 ms (milliseconds) in duration (e.g., 40, 100, or 120 ms, depending on the magnitude of the second intensity threshold, with the delay time increasing as the second intensity threshold increases). This delay time helps to avoid accidental recognition of deep press inputs. As another example, for some “deep press” inputs, there is a reduced-sensitivity time period that occurs

## US 11,106,352 B2

35

after the time at which the first intensity threshold is met. During the reduced-sensitivity time period, the second intensity threshold is increased. This temporary increase in the second intensity threshold also helps to avoid accidental deep press inputs. For other deep press inputs, the response to detection of a deep press input does not depend on time-based criteria.

In some embodiments, one or more of the input intensity thresholds and/or the corresponding outputs vary based on one or more factors, such as user settings, contact motion, input timing, application running, rate at which the intensity is applied, number of concurrent inputs, user history, environmental factors (e.g., ambient noise), focus selector position, and the like. Example factors are described in U.S. patent application Ser. Nos. 14/399,606 and 14/624,296, which are incorporated by reference herein in their entireties.

For example, FIG. 4C illustrates a dynamic intensity threshold 480 that changes over time based in part on the intensity of touch input 476 over time. Dynamic intensity threshold 480 is a sum of two components, first component 474 that decays over time after a predefined delay time p1 from when touch input 476 is initially detected, and second component 478 that trails the intensity of touch input 476 over time. The initial high intensity threshold of first component 474 reduces accidental triggering of a “deep press” response, while still allowing an immediate “deep press” response if touch input 476 provides sufficient intensity. Second component 478 reduces unintentional triggering of a “deep press” response by gradual intensity fluctuations of in a touch input. In some embodiments, when touch input 476 satisfies dynamic intensity threshold 480 (e.g., at point 481 in FIG. 4C), the “deep press” response is triggered.

FIG. 4D illustrates another dynamic intensity threshold 486 (e.g., intensity threshold  $I_D$ ). FIG. 4D also illustrates two other intensity thresholds: a first intensity threshold  $I_H$  and a second intensity threshold  $I_L$ . In FIG. 4D, although touch input 484 satisfies the first intensity threshold  $I_H$  and the second intensity threshold  $I_L$  prior to time p2, no response is provided until delay time p2 has elapsed at time 482. Also in FIG. 4D, dynamic intensity threshold 486 decays over time, with the decay starting at time 488 after a predefined delay time p1 has elapsed from time 482 (when the response associated with the second intensity threshold  $I_L$  was triggered). This type of dynamic intensity threshold reduces accidental triggering of a response associated with the dynamic intensity threshold  $I_D$  immediately after, or concurrently with, triggering a response associated with a lower intensity threshold, such as the first intensity threshold  $I_H$  or the second intensity threshold  $I_L$ .

FIG. 4E illustrate yet another dynamic intensity threshold 492 (e.g., intensity threshold  $I_D$ ). In FIG. 4E, a response associated with the intensity threshold  $I_L$  is triggered after the delay time p2 has elapsed from when touch input 490 is initially detected. Concurrently, dynamic intensity threshold 492 decays after the predefined delay time p1 has elapsed from when touch input 490 is initially detected. So a decrease in intensity of touch input 490 after triggering the response associated with the intensity threshold  $I_L$ , followed by an increase in the intensity of touch input 490, without releasing touch input 490, can trigger a response associated with the intensity threshold  $I_D$  (e.g., at time 494) even when the intensity of touch input 490 is below another intensity threshold, for example, the intensity threshold  $I_L$ .

An increase of characteristic intensity of the contact from an intensity below the light press intensity threshold  $IT_L$  to an intensity between the light press intensity threshold  $IT_L$

36

and the deep press intensity threshold  $ITS$  is sometimes referred to as a “light press” input. An increase of characteristic intensity of the contact from an intensity below the deep press intensity threshold  $ITS$  to an intensity above the deep press intensity threshold  $ITS$  is sometimes referred to as a “deep press” input. An increase of characteristic intensity of the contact from an intensity below the contact-detection intensity threshold  $IT_0$  to an intensity between the contact-detection intensity threshold  $IT_0$  and the light press intensity threshold  $IT_L$  is sometimes referred to as detecting the contact on the touch-surface. A decrease of characteristic intensity of the contact from an intensity above the contact-detection intensity threshold  $IT_0$  to an intensity below the contact-detection intensity threshold  $IT_0$  is sometimes referred to as detecting liftoff of the contact from the touch-surface. In some embodiments  $IT_0$  is zero. In some embodiments,  $IT_0$  is greater than zero. In some illustrations a shaded circle or oval is used to represent intensity of a contact on the touch-sensitive surface. In some illustrations, a circle or oval without shading is used represent a respective contact on the touch-sensitive surface without specifying the intensity of the respective contact.

In some embodiments, described herein, one or more operations are performed in response to detecting a gesture that includes a respective press input or in response to detecting the respective press input performed with a respective contact (or a plurality of contacts), where the respective press input is detected based at least in part on detecting an increase in intensity of the contact (or plurality of contacts) above a press-input intensity threshold. In some embodiments, the respective operation is performed in response to detecting the increase in intensity of the respective contact above the press-input intensity threshold (e.g., the respective operation is performed on a “down stroke” of the respective press input). In some embodiments, the press input includes an increase in intensity of the respective contact above the press-input intensity threshold and a subsequent decrease in intensity of the contact below the press-input intensity threshold, and the respective operation is performed in response to detecting the subsequent decrease in intensity of the respective contact below the press-input threshold (e.g., the respective operation is performed on an “up stroke” of the respective press input).

In some embodiments, the device employs intensity hysteresis to avoid accidental inputs sometimes termed “jitter,” where the device defines or selects a hysteresis intensity threshold with a predefined relationship to the press-input intensity threshold (e.g., the hysteresis intensity threshold is X intensity units lower than the press-input intensity threshold or the hysteresis intensity threshold is 75%, 90%, or some reasonable proportion of the press-input intensity threshold). Thus, in some embodiments, the press input includes an increase in intensity of the respective contact above the press-input intensity threshold and a subsequent decrease in intensity of the contact below the hysteresis intensity threshold that corresponds to the press-input intensity threshold, and the respective operation is performed in response to detecting the subsequent decrease in intensity of the respective contact below the hysteresis intensity threshold (e.g., the respective operation is performed on an “up stroke” of the respective press input). Similarly, in some embodiments, the press input is detected only when the device detects an increase in intensity of the contact from an intensity at or below the hysteresis intensity threshold to an intensity at or above the press-input intensity threshold and, optionally, a subsequent decrease in intensity of the contact to an intensity at or below the hysteresis intensity, and the



respective operation is performed in response to detecting the press input (e.g., the increase in intensity of the contact or the decrease in intensity of the contact, depending on the circumstances).

For ease of explanation, the description of operations performed in response to a press input associated with a press-input intensity threshold or in response to a gesture including the press input are, optionally, triggered in response to detecting: an increase in intensity of a contact above the press-input intensity threshold, an increase in intensity of a contact from an intensity below the hysteresis intensity threshold to an intensity above the press-input intensity threshold, a decrease in intensity of the contact below the press-input intensity threshold, or a decrease in intensity of the contact below the hysteresis intensity threshold corresponding to the press-input intensity threshold. Additionally, in examples where an operation is described as being performed in response to detecting a decrease in intensity of a contact below the press-input intensity threshold, the operation is, optionally, performed in response to detecting a decrease in intensity of the contact below a hysteresis intensity threshold corresponding to, and lower than, the press-input intensity threshold. As described above, in some embodiments, the triggering of these responses also depends on time-based criteria being met (e.g., a delay time has elapsed between a first intensity threshold being met and a second intensity threshold being met).

User Interfaces and Associated Processes

Attention is now directed towards embodiments of user interfaces ("UI") and associated processes that may be implemented on an electronic device, such as portable multifunction device 100 or device 300, with a display, a touch-sensitive surface, (optionally) one or more tactile output generators for generating tactile outputs, and (optionally) one or more sensors to detect intensities of contacts with the touch-sensitive surface.

FIGS. 5A-5AZ illustrate example user interfaces for clearing sets of notifications in accordance with some embodiments. The user interfaces in these figures are used to illustrate the processes described below, including the processes in FIGS. 6A-6G. For convenience of explanation, some of the embodiments will be discussed with reference to operations performed on a device with a touch-sensitive display system 112. In such embodiments, the focus selector is, optionally: a respective finger or stylus contact, a representative point corresponding to a finger or stylus contact (e.g., a centroid of a respective contact or a point associated with a respective contact), or a centroid of two or more contacts detected on the touch-sensitive display system 112. However, analogous operations are, optionally, performed on a device with a display 450 and a separate touch-sensitive surface 451 in response to detecting the contacts on the touch-sensitive surface 451 while displaying the user interfaces shown in the figures on the display 450, along with a focus selector.

FIGS. 5A1 to 5A4 illustrate activation of a display (e.g., touch-sensitive display 112) in response to changing an orientation of device 100. When the display has been activated, notifications that were received while the device was in a screen-off state were received. These notifications are displayed when the device transitions to a screen-on state. In some embodiments, the device uses one or more sensors (e.g., accelerometer, gyro, audio sensor, heat sensor, and/or light sensor) to determine whether an orientation of the device has changed. For example, the device determines

whether the device has been rotated by more than a threshold angle (e.g., rotated along an axis of the device, such as tilted from a position in which the device is substantially horizontal to a position in which the device is substantially vertical). In FIG. 5A1, the device is in a screen-off state while it is held flat in a user's hand 502, such that the device display is substantially horizontal. In FIG. 5A2, the device is tilted such that the display is more vertical than in FIG. 5A1. Because a tilt angle of the device has not increased above a threshold tilt angle in FIG. 5A2, the display is not activated. In FIG. 5A3, the device is tilted such that the display is more vertical than in FIG. 5A2. Because a tilt angle of the device has increased above a threshold tilt angle in FIG. 5A3, the display has transitioned from a screen-off state to a screen-on state and wake screen user interface 504 is displayed by the display 112. In FIG. 5A4, the display 112 is substantially vertical.

In some embodiments, wake screen user interface 504 is a user interface that is displayed when the device transitions from a screen-off state to a screen-on state (e.g., while the device 100 is in a locked state) and wake screen user interface 504 is available to be redisplayed (e.g., to allow a user to view notifications, access a mini application user interface and/or access a control center user interface, as described further below) after the device is unlocked. In some embodiments, when wake screen user interface 504 is accessed after the device is unlocked, wake screen user interface 504 is referred to as a cover sheet user interface. The terms "wake screen user interface" and "cover sheet user interface" are used interchangeably herein to refer to wake screen user interface 504.

FIG. 5B illustrates a wake screen user interface 504, in accordance with some embodiments. Wake screen user interface 504 displays missed notifications 506, 508, 510, and 512 that were received and/or generated by device 100 (e.g., while device 100 was in a screen-off state).

In some embodiments, the missed notifications that are displayed on the wake screen user interface 504 are cleared individually in response to user interaction with a notification (e.g., when a user accesses an application that corresponds to a notification, as illustrated at FIGS. 5L-5M, or when a user provides input to delete a notification, as illustrated at FIGS. 5Y-5AC). In some embodiments, a set of all missed notifications are collectively cleared when notification clearance criteria are satisfied, e.g., when input is received at a time that is (1) after a respective notification of the one or more notifications has been cleared through direct user interaction with the respective notification or an application that corresponds to the respective notification and (2) after the device has transitioned from the screen-on state to the screen-off state at least once since the last direct user interaction that dismissed a respective notification.

In FIGS. 5B-5D, the device transitions from a screen-on state to a screen-off state. Since this transition has not occurred after a user interaction to dismiss a notification, the missed notifications remain displayed, as shown in FIG. 5D.

After device 100 transitions from a screen-off state, as shown in FIG. 5A, to a screen-on state, as shown in FIG. 5B, the device 100 transitions from the screen-on state back to a screen-off state, as shown in FIG. 5C. In some embodiments, a transition from a screen-on state to a screen-off state (and/or from a screen-off state to a screen-on state) occurs in response to an input detected at a control (e.g., a push button 206) of device 100. In some embodiments, a transition from a screen-on state to a screen-off state occurs when a time during which no input has been detected by the device increases beyond a threshold duration.



## US 11,106,352 B2

39

In FIG. 5D, the device has transitioned from the screen-off state shown in FIG. 5C back to a screen-on state. Notifications 506, 508, 510, and 512 continue to be displayed after the transition from a screen-on state (as shown in FIG. 5B) to a screen-off state (as shown in FIG. 5C) and back to a screen-on state (as shown in FIG. 5D).

In FIGS. 5E-5K, a set of missed notifications remains available on wake screen user interface 504 after user input is provided to unlock the device.

FIG. 5E illustrates an input (e.g., an upward swipe) by a contact on touch screen 112 that is initiated at a lower edge of touch screen 112, as indicated by focus selector 514. In response to the input, in accordance with a determination that the device is locked, an authentication user interface 518 is displayed, as shown in FIG. 5F.

In FIG. 5G, an authentication input (e.g., a tap input) by a contact on touch screen 112 is detected at a location within authentication user interface 518, as indicated by focus selector 520. In response to the authentication input, the device is unlocked and home screen user interface 522 (e.g., a user interface for a menu of applications as described with regard to FIG. 4A) is displayed, as shown in FIG. 5H.

FIGS. 5I-5J illustrate an input (e.g., a downward swipe) that is initiated by a contact at an upper edge of touch screen 112, as indicated by focus selector 524. In response to the input, wake screen user interface 504 slides down from the upper edge of display 112, as shown in FIGS. 5I-5K. As indicated in FIG. 5K, notifications 506, 508, 510, and 512 continue to be displayed on the wake screen user interface 504 when wake screen user interface 504 is revealed after the device is unlocked and home screen user interface 522 is displayed.

FIGS. 5L-5M illustrate a user interaction with notification 510 that causes the notification to be dismissed (as shown in FIG. 5P), while notifications 506, 508, and 512 remain displayed on wake screen user interface 504 (e.g., because no transition from the screen-on state to the screen-off state has occurred since the user interaction to dismiss notification 510).

In FIG. 5L, an input (e.g., a tap input) by a contact on touch screen 112 is detected at a location that corresponds to notification 510, as indicated by focus selector 528. In response to the input, wake screen user interface 504 ceases to be displayed and an application user interface (e.g., messages application user interface 530) that corresponds to the notification 510 is displayed, as shown in FIG. 5M.

FIGS. 5N-5O illustrate an input (e.g., a downward swipe) that is initiated by a contact on touch screen 112 at an upper edge of touch screen 112, as indicated by focus selector 532. In response to the input, wake screen user interface 504 slides down from the upper edge of display 112, as shown in FIGS. 5N-5P. As indicated in FIG. 5P, as a result of the interaction with notification 510 (e.g., the tap input on notification 510 that caused the messages application user interface 530 to be displayed) notification 510 is no longer displayed on wake screen user interface 504. In FIG. 5P, notifications 506, 508, and 512 continue to be displayed on the wake screen user interface 504.

In FIGS. 5Q-5X, after navigation to a first application user interface and from the first application user interface to a second application user interface, notifications 506, 508, and 512 continue to be displayed (as shown in FIG. 5X).

FIG. 5Q illustrates an input (e.g., an upward swipe) that is initiated by a contact at a location near the lower edge of touch screen 112, as indicated by focus selector 534. In response to the input, wake screen user interface 504 slides up from the lower edge of display 112 to redisplay the

40

underlying messages application user interface 530 (that was previously covered by wake screen user interface 504), as shown in FIGS. 5Q-5R.

FIG. 5S illustrates an input by a contact on touch screen 112 that is initiated by a contact at a location near the lower edge of touch screen 112, as indicated by focus selector 536. In response to the input, during which the focus selector moves along a path indicated by arrow 538, messages application user interface 530 moves along the path indicated by arrow 538 to reveal web browser application user interface 540, as shown in FIGS. 5S-5U.

FIGS. 5V-5W illustrate an input (e.g., a downward swipe) that is initiated by a contact at a location near the upper edge of touch screen 112, as indicated by focus selector 542. In response to the input, wake screen user interface 504 slides down from the lower edge of display 112, as shown in FIGS. 5V-5X.

FIGS. 5Y-5AC illustrate a user interaction with notification 506 that causes notification 506 to be dismissed (as shown in FIG. 5AC), while notifications 508 and 512 remain displayed on wake screen user interface 504 (e.g., because no transition from the screen-on state to the screen-off state has occurred since the user interaction to dismiss notification 510 and no transition from the screen-on state to the screen-off state has occurred since the user interaction to dismiss notification 506).

FIGS. 5AD-5AO illustrate user input to access a music application user interface 560 and to initiate an active playback mode of the music application. While the music application is in an active playback mode, a media banner 568 is displayed on wake screen user interface 504, as shown in FIG. 5AO. FIGS. 5AP-5AU illustrate input to stop media playback. When music application is not in an active playback mode, media banner 568 is no longer displayed on wake screen user interface 504, as shown in FIG. 5AU.

FIGS. 5Y-5Z illustrate an input (e.g., a horizontal drag input) by a contact on touch screen 112 at a location that corresponds to notification 506, as indicated by focus selector 544. In response to the input, deletion affordance 546 is revealed at a location that is adjacent to notification 506, as shown in FIG. 5Z. In FIG. 5AA, the contact indicated by focus selector 544 has lifted off of touch screen 112.

In FIG. 5AB, an input (e.g., a tap input) is detected at a location that corresponds to deletion affordance 546, as indicated by focus selector 548. In response to the input, notification 506 ceases to be displayed on wake screen user interface 504, as shown in FIG. 5AC. In FIG. 5AC, notifications 508 and 512 continue to be displayed on the wake screen user interface 504.

FIGS. 5AD-5AE illustrate an input (e.g., an upward swipe) that is initiated by a contact at a location near the upper edge of touch screen 112, as indicated by focus selector 550. In response to the input, wake screen user interface 504 slides up from the lower edge of display 112 to redisplay the underlying web browser application user interface 540 (that was previously covered by wake screen user interface 504), as shown in FIGS. 5AD-5AF.

FIG. 5AG illustrates an input (e.g., an upward swipe) by a contact on touch screen 112 that is initiated by a contact at location that corresponds to home affordance 552, as indicated by focus selector 554. In response to the input, display of web browser application user interface 540 is replaced by display of home screen user interface 522, as shown in FIGS. 5AG-5AH.

In FIG. 5AI, an input (e.g., a tap input) is detected at a location that corresponds to affordance 556 for displaying a music application interface, as indicated by focus selector

558. In response to the input, a music application user interface 552 is displayed, as shown in FIG. 5AJ.

In FIG. 5AK, an input (e.g., a tap input) is detected at a location that corresponds to media playback control affordance 562, as indicated by focus selector 564. In response to the input, the music application transitions to an active playback mode (e.g., music playback is initiated) as shown in FIG. 5AL (e.g., as indicated by the changed state of media playback control affordance 562).

FIGS. 5AM-5AN illustrate an input (e.g., a downward swipe) that is initiated by a contact at a location near the upper edge of touch screen 112, as indicated by focus selector 566. In response to the input, wake screen user interface 504 slides down from the upper edge of display 112, as shown in FIGS. 5AM-5AO.

FIG. 5AO shows a wake screen user interface 504 that displays a media banner 568 that corresponds to the ongoing music playback initiated from the music application. As indicated in FIG. 5AP, media banner 568 includes media track information 570 and a banner playback control affordance 572.

In FIG. 5AP, an input (e.g., a tap input) is detected at a location that corresponds to banner playback control affordance 572, as indicated by focus selector 574. In response to the input, music playback is paused as shown in FIG. 5AQ (e.g., as indicated by the changed state of banner playback control affordance 572).

FIG. 5AR illustrates an input (e.g., an upward swipe) that is initiated by a contact near the lower edge of touch screen 112, as indicated by focus selector 576. In response to the input, wake screen user interface 504 slides up from the lower edge of display 112 to redisplay the underlying music user interface 522 (that was previously covered by wake screen user interface 504), as shown in FIGS. 5AR-5AS.

FIG. 5AT illustrates an input (e.g., a downward swipe) by a contact on touch screen 112, as indicated by focus selector 578. In response to the input, wake screen user interface 504 slides down from the upper edge of display 112, as shown in FIGS. 5AT-5AU.

In FIG. 5AU, media banner 568 is no longer displayed on wake screen user interface 504 (e.g., because the input to display wake screen user interface 504 was received while the music application was not in an active media playback mode).

FIGS. 5AV-5AW illustrate a transition from the screen-on state to the screen-off state that occurs after the user interaction to dismiss notification 510 (e.g., as described with regard to FIGS. 5L-5P) and after the user interaction to dismiss notification 606 (as described with regard to FIGS. 5Y-5AC). As shown in FIG. 5AW, because notification clearance criteria are satisfied (e.g., input (to transition the device from the screen-off state to the screen-on state) is received at a time that is (1) after a respective notification of the one or more notifications has been cleared through direct user interaction with the respective notification or an application that corresponds to the respective notification and (2) after the device has transitioned from the screen-on state to the screen-off state at least once since the last direct user interaction that dismissed a respective notification), all notifications have been cleared from wake screen 504.

In FIG. 5AV, device 100 has transitioned from the screen-on state, as shown in FIG. 5AU, to a screen-off state.

After the screen has transitioned from a screen-off state, as shown in FIG. 5AV, back to a screen-on state, as shown in FIG. 5AW (and after the user has interacted with at least one notification, e.g., as described with regard to FIGS.

5L-5P and/or as described with regard to FIGS. 5Y-5AC), wake screen user interface 504 is displayed with no notifications.

FIGS. 5AW-5AZ illustrate a “rubber band” effect that occurs when an input by a contact with touch screen 112 (as indicated by focus selector 580) drags a time/date indicator 582 downward, and then the time/date indicator moves back to its original position in response to lift off of the contact from the touch sensitive surface. As focus selector 580 moves across touch screen 112 along a path indicated by arrow 584, time/date indicator 582 moves in accordance with the movement of the focus selector 580, as shown in FIGS. 5AW-5AX. When focus selector 580 lifts off of touch screen 112, the time/date indicator 582 returns to its original position, as shown in FIGS. 5AY-5AZ.

FIGS. 5BA-5CX illustrate example user interfaces for displaying notification history, in accordance with some embodiments. The user interfaces in these figures are used to illustrate the processes described below, including the processes in FIGS. 7A-7E. For convenience of explanation, some of the embodiments will be discussed with reference to operations performed on a device with a touch-sensitive display system 112. In such embodiments, the focus selector is, optionally: a respective finger or stylus contact, a representative point corresponding to a finger or stylus contact (e.g., a centroid of a respective contact or a point associated with a respective contact), or a centroid of two or more contacts detected on the touch-sensitive display system 112. However, analogous operations are, optionally, performed on a device with a display 450 and a separate touch-sensitive surface 451 in response to detecting the contacts on the touch-sensitive surface 451 while displaying the user interfaces shown in the figures on the display 450, along with a focus selector.

FIG. 5BA displays wake screen user interface 504 (e.g., in response to an event that triggered a transition from a screen-off state to a screen-on state). Wake screen user interface 504 displays missed notifications 586, 588, 590, and 592.

FIGS. 5BB-5BE illustrate a “rubber band” effect that occurs when an input by a contact with touch screen 112 (as indicated by focus selector 594) drags missed notifications 586, 588, 590, and 592 and time/date indicator 582 downward, and then the missed notifications 586, 588, 590, and 592 and time/date indicator 582 move back to their original positions in response to lift off of the contact from the touch sensitive surface. As focus selector 594 moves across touch screen 112 along a path indicated by arrow 596, missed notifications 586, 588, 590, and 592 and time/date indicator 582 move in accordance with the movement of the focus selector 594, as shown in FIGS. 5BB-5BC. When focus selector 594 lifts off of touch screen 112, notifications 586, 588, 590, and 592 and time/date indicator 582 return to their original positions, as shown in FIGS. 5BD-5BE.

FIGS. 5BF-5BG illustrate an input (e.g., an upward swipe) that causes missed notifications to scroll upwards, but that does not meet criteria for displaying previously received notifications. In FIG. 5BF, an input is initiated by a contact with touch screen 112, as indicated by focus selector 598, within a region on wake screen interface 504 (e.g., a region delineated by dotted line 5100) in which notifications 586-592 are displayed. In response to the input, missed notifications 586-592 move upward, as shown in FIGS. 5BF-5BG, revealing an additional missed notification 5102 and a previously received notification indicator 5104, as shown in FIG. 5BH.



## US 11,106,352 B2

43

FIGS. 5BI-5BN illustrate an input that meets criteria for displaying previously received notifications. In FIG. 5BI, an input (e.g., an upward swipe) is initiated by a contact with touch screen 112 (e.g., at a location that corresponds to previously received notification indicator 5102), as indicated by focus selector 5106. In response to the input, missed notifications 586-592 move upward, as shown in FIGS. 5BJ-5BP. As shown in FIG. 5BK, when movement of the focus selector 5106 across touch screen 112 has increased above a threshold distance (as indicated by 5108), previously received notification 506 is displayed, and the device generates a tactile output (as indicated at 5112). After the focus selector 5106 moves beyond the threshold distance, additional previously received notifications 508 and 510 are displayed, and the previously received notifications 506, 508, and 510 move at a faster rate than the rate of movement of focus selector 5106 and missed notifications 590, 592 and 5102 (e.g., to provide a visual effect of the previously received notifications 506, 508, and 510 "rushing to catch up" with the missed notifications 590, 592 and 5102), as shown in FIGS. 5BK-5BM. In FIGS. 5BM-5BN, focus selector 5106 continues to move upward across touch screen 112, and previously received notification 512 is revealed. In FIGS. 5BO-5BP, after the contact indicated by focus selector 5106 has lifted off from touch screen 112, previously received notifications 506, 508, 510, and 512 continue to move upward.

FIGS. 5BQ-5BR illustrate an input that displays additional previously received notifications. In FIG. 5BQ, an input (e.g., an upward swipe) is initiated by a contact with touch screen 112, as indicated by focus selector 5120, within a region on wake screen interface 504 in which previously received notifications 506-512 are displayed. In response to the input, previously received notifications 506-512 move upward, as shown in FIGS. 5BQ-5BR. In FIG. 5BR, a second previously received notification indicator 5122 (e.g., for notifications received on the previous day) and a previously received notification 5124 (e.g., received on the previous day) are displayed on wake screen user interface 504.

FIGS. 5BS-5BT illustrate an input to redisplay missed notifications. In FIG. 5BS, an input (e.g., a downward swipe) is initiated by a contact with touch screen 112, as indicated by focus selector 5126, within a region on wake screen interface 504 in which previously received notifications 506-512 and 5124 are displayed. In response to the input, previously received notifications 506-512 and 5124 scroll downwards and missed notifications 590, 592, and 5102 are redisplayed on wake screen user interface 504, as shown in FIGS. 5BS-5BU.

FIGS. 5BV-5BZ illustrate a user interaction with notification 592 that causes the notification to be dismissed (as shown in FIG. 5BZ), while missed notifications other than 592 and previously received notifications remain displayed on wake screen user interface 504 (e.g., because no transition from the screen-on state to the screen-off state has occurred since the user interaction to dismiss notification 592).

FIGS. 5BV-5BW illustrate an input (e.g., a horizontal drag input) by a contact on touch screen 112 at a location that corresponds to notification 592, as indicated by focus selector 5128. In response to the input, deletion affordance 5130 is revealed at a location that is adjacent to notification 592, as shown in FIG. 5BW. In FIG. 5BX, the contact indicated by focus selector 5130 has lifted off of touch screen 112.

In FIG. 5BY, an input (e.g., a tap input) is detected at a location that corresponds to deletion affordance 5130, as indicated by focus selector 5132. In response to the input,

44

notification 592 ceases to be displayed on wake screen user interface 504, as shown in FIG. 5BZ.

FIG. 5CA illustrates an input that meets criteria for dismissing previously dismissed notifications. In response to the input, only missed notifications remain displayed on wake screen 504, as shown in FIG. 5CB.

FIGS. 5CA-5CB illustrate an input (e.g., a downward swipe) that is initiated by a contact with touch screen 112, as indicated by focus selector 5136, within a region on wake screen interface 504 in which missed notifications (e.g., 592 and 5102) and/or previously received notifications (e.g., 506-510) are displayed. In response to the input, previously received notifications 506-510 scroll downwards and missed notifications 586, 588, 592, and 5102 are redisplayed on wake screen user interface 504, as shown in FIG. 5CA-5CB.

FIGS. 5CC-5CQ illustrate input for accessing a control center user interface 5138, a mini application user interface 5140, and a user interface underlying wake screen user interface (e.g., home screen user interface 522) from wake screen user interface 504.

FIGS. 5CC-5CD illustrate an input (e.g., a leftward swipe) that is initiated by a contact on touch screen 112, as indicated by focus selector 5136. In response to the input, wake screen user interface 504 slides to the left and control center user interface 5138 is revealed, as shown in FIG. 5CC-5CE.

FIGS. 5CF-5CG illustrate an input (e.g., a rightward swipe) that is initiated by a contact on touch screen 112, as indicated by focus selector 5142. In response to the input, control center user interface 5138 slides to the right and wake screen user interface 504 is revealed, as shown in FIG. 5CF-5CH.

FIGS. 5CI-5CJ illustrate an input (e.g., a rightward swipe) that is initiated by a contact on touch screen 112, as indicated by focus selector 5144. In response to the input, wake screen user interface 504 slides to the right and mini application user interface 5140 is revealed, as shown in FIG. 5CI-5CK.

FIGS. 5CL-5CM illustrate an input (e.g., a leftward swipe) that is initiated by a contact on touch screen 112, as indicated by focus selector 5146. In response to the input, mini application user interface 5140 slides to the left and wake screen user interface 504 is revealed, as shown in FIG. 5CL-5CN.

FIG. 5CO illustrates an input by a contact on touch screen 112 that is initiated at a lower edge of touch screen 112, as indicated by focus selector 5146. In response to the input, display of wake screen user interface 504 is replaced by display of home screen user interface 522, as shown in FIGS. 5CO-5CQ.

FIGS. 5CR-5CS illustrate a transition from the screen-on state to the screen-off state that occurs after the user interaction to dismiss notification 592 (e.g., as described with regard to FIGS. 5BV-5BZ). As shown in FIG. 5CS, because notification clearance criteria are satisfied (e.g., input (to transition the device from the screen-off state to the screen-on state) is received at a time that is (1) after a respective notification of the one or more notifications has been cleared through direct user interaction with the respective notification or an application that corresponds to the respective notification and (2) after the device has transitioned from the screen-on state to the screen-off state at least once since the last direct user interaction that dismissed a respective notification), all notifications have been cleared from wake screen 504.

In FIG. 5CR, device 100 has transitioned from the screen-on state, as shown in FIG. 5CQ, to a screen-off state.

## US 11,106,352 B2

45

After the screen has transitioned from a screen-off state, as shown in FIG. 5CR, back to a screen-on state, as shown in FIG. 5CS (and after the user has interacted with at least one notification, e.g., as described with regard to FIGS. 5BV-5BZ), wake screen user interface 504 is displayed with no notifications.

FIGS. 5CS-5CV illustrate a “rubber band” effect that occurs when an input by a contact with touch screen 112 (as indicated by focus selector 5150) drags a time/date indicator 582 downward, and then the time/date indicator moves back to its original position in response to lift off of the contact from the touch sensitive surface.

After all notifications have been cleared, as shown at FIG. 5CS, the cleared notifications can be recalled, as shown at FIGS. 5CW-5CX. FIG. 5CW illustrates an input (e.g., an upward swipe) that is initiated by a contact with touch screen 112 at a location on wake screen user interface 504, as indicated by focus selector 5152. In response to the input, the notifications that were displayed as missed notifications 586-592 and subsequently cleared (as described with regard to FIGS. 5BA, 5BV-5BZ, and 5CR-5CS) move upward when movement of the focus selector 5152 across touch screen 112 has increased above a threshold distance. In FIG. 5CX, the notifications that were displayed as missed notifications 586-592 are displayed as previously received notifications.

FIGS. 5CY-5EB illustrate example user interfaces for displaying updating information from an application in a floating banner, in accordance with some embodiments. The user interfaces in these figures are used to illustrate the processes described below, including the processes in FIGS. 8A-8C. For convenience of explanation, some of the embodiments will be discussed with reference to operations performed on a device with a touch-sensitive display system 112. In such embodiments, the focus selector is, optionally: a respective finger or stylus contact, a representative point corresponding to a finger or stylus contact (e.g., a centroid of a respective contact or a point associated with a respective contact), or a centroid of two or more contacts detected on the touch-sensitive display system 112. However, analogous operations are, optionally, performed on a device with a display 450 and a separate touch-sensitive surface 451 in response to detecting the contacts on the touch-sensitive surface 451 while displaying the user interfaces shown in the figures on the display 450, along with a focus selector.

FIGS. 5CY-5DA illustrate input for activating a navigation mode of a maps application and displaying a navigation banner 5160 that corresponds to the active navigation mode of the maps application.

FIG. 5CY shows a maps application user interface 5154 displayed by display 112 of device 100.

In FIG. 5CZ, an input (e.g., a tap input) by a contact on touch screen 112 is detected at a location that corresponds to a control 5156 for activating a navigation mode of the maps application, as indicated by focus selector 5158. In response to the input, the navigation mode of the maps application is initiated, and a navigation mode user interface is displayed in maps application user interface 5154, as indicated at FIG. 5DA. A navigation banner 5160 (e.g., that includes navigation direction text and/or a navigation direction image, such as a direction arrow) is displayed on the navigation mode user interface of the maps application user interface 5154.

In FIGS. 5DB-5DF, the “floating” aspect of navigation banner 5160 is illustrated, as navigation banner 5160 continues to be displayed overlying cover sheet user interface 504 (referred to above as wake screen user interface 504) as cover sheet user interface 504 slides down to cover maps

46

application user interface 5154. FIGS. 5DD-5DE illustrate how navigation banner 5160 is anchored to time/date object 582 in cover sheet user interface 504.

FIGS. 5DB-5DF illustrate an input (e.g., a downward swipe) by a contact on touch screen 112 that is initiated at an upper edge of touch screen 112, as indicated by focus selector 5162. In response to the input, cover sheet user interface 504 slides down from the upper edge of display 112, as shown in FIGS. 5DC-5DF. As shown in FIGS. 5DC-5DD, notifications 5164 and 5168 that are displayed on cover sheet user interface 504 descend as cover sheet user interface 504 slides down, while navigation banner 5160 remains at a fixed position on cover sheet 504 (e.g., cover sheet 504 and its notifications 5164 and 5168 appear to slide down behind navigation banner 5160). As shown in FIGS. 5DD-5DE, in accordance with a determination that cover sheet user interface 504 has descended a threshold distance relative to navigation banner 5160, navigation banner 5160 becomes “attached” to the cover sheet user interface and begins to move downward while cover sheet user interface 504 moves downward. As shown in FIGS. 5DD-5DE, a time/date object 582 that is displayed on cover sheet user interface 504 is gradually revealed as cover sheet user interface 504 moves downward. In accordance with a determination that the time/date object 582 has reached a pre-defined location on the display, time/date object 582 and navigation banner 5160 cease to move as the cover sheet user interface 504 continues its descent (and notifications 5164 and 5168 continue to move downward with the cover sheet user interface 504).

In FIG. 5DG, the contact indicated by focus selector 5162 has lifted off of cover sheet user interface 504.

FIGS. 5DH-5DI illustrate input at navigation banner 5160 to display the user interface 5154 of the corresponding maps application.

In FIG. 5DH, an input (e.g., a tap input) by a contact on touch screen 112 is detected at a location that corresponds to navigation banner 5160, as indicated by focus selector 5168. In response to the input, cover sheet user interface 504 ceases to be displayed and maps application user interface 5154 is redisplayed, as indicated at FIG. 5DI. In FIG. 5DI, navigation banner 5160 is displayed on the navigation mode user interface of the maps application user interface 5154.

FIGS. 5DJ-5DS illustrate input to display a home screen user interface 522 (over which navigation banner 5160 continues to be displayed), to pull down cover sheet user interface 504 over home screen user interface 522, and to show the continuous display of navigation banner 5160 as home screen user interface 522 is revealed from under cover sheet 522.

FIG. 5DJ illustrates an input by a contact on touch screen 112 that is initiated by a contact at location that corresponds to home affordance 552, as indicated by focus selector 5170. In response to the input, display of map application user interface 5154 is replaced by display of home screen user interface 522, as shown in FIGS. 5DJ-5DM. Navigation banner 5160 remains displayed at the same position during the transition from displaying map application user interface 5154 to displaying home screen user interface 522. Navigation banner 5160 is displayed overlaying home screen user interface 522.

FIGS. 5DN-5DO illustrate an input (e.g., a downward swipe) that is initiated by a contact at a location near the upper edge of touch screen 112, as indicated by focus selector 5172. In response to the input, cover sheet user interface 504 slides down from the upper edge of display 112, as shown in FIGS. 5DN-5DP.



FIG. 5DQ illustrates an input (e.g., an upward swipe input) by a contact on touch screen 112 that is initiated by a contact at location indicated by focus selector 5174. In response to the input, display of cover sheet user interface 504 is replaced by display of home screen user interface 522, as shown in FIGS. 5DQ-5DS.

FIGS. 5DT-5DW illustrate input that causes transition of navigation banner 5160 from a banner form (as shown in FIG. 5DT) to pill form (as shown in FIG. 5DW).

FIGS. 5DT-5DU illustrate an input (e.g., an upward swipe) that is initiated by a contact at a location that corresponds to navigation banner 5160, as indicated by focus selector 5176. In response to the input, navigation banner 5160 gradually transitions from a banner format, as shown in FIG. 5DT, to a pill format, as shown in FIG. 5DW. For example, as navigation banner 5160 gradually transitions from a banner format to a pill format, an animation is displayed in which navigation text 5178 in navigation banner 5160 ceases to be displayed, navigation direction arrow 5180 shrinks, navigation banner 5160 gradually shrinks and moves leftward, and a time 5182 is displayed (e.g., adjacent to navigation direction arrow 5180) in the pill format of navigation banner 5160.

FIGS. 5DX-5DW illustrate input on navigation banner 5160 (in the pill format) that causes an application that corresponds to the banner to be displayed.

In FIG. 5DX, an input (e.g., a tap input) by a contact on touch screen 112 is detected at a location that corresponds to navigation banner 5160 (in the pill format), as indicated by focus selector 5184. In response to the input, because the content of navigation banner 5160 (in the pill format) corresponds to the navigation mode of the map application, home screen user interface 522 ceases to be displayed and maps application user interface 5154 is redisplayed, as indicated at FIG. 5DY. In FIG. 5DY, navigation banner 5160 is displayed on the navigation mode user interface of the maps application user interface 5154.

FIGS. 5DZ-5EA illustrate banners that are displayed on device 100 when device 100 is in a screen-off state.

In FIG. 5DZ, device 100 has transitioned from the screen-on state, as shown in FIG. 5DY, to a screen-off state. Because the navigation mode of the map application was active when the device 100 transitioned to the screen-off state, navigation banner 5160 is displayed on device 100 while the device is in the "screen-off" state (e.g., aside from displaying the navigation banner 5160, the display 112 is blank).

In FIG. 5EA, while the device 100 is in the "screen-off" state, a notification 5186 is received. The received notification 5186 is displayed on display 112 of device 100 while the device 100 is in the "screen-off state" (e.g., aside from displaying the received notification 5186 and/or the navigation banner 5160, the display 112 is blank).

In FIG. 5EB, device 100 has transitioned from the screen-off state, as shown in FIGS. 5DZ-5EA, to a screen-on state, and cover sheet user interface 504 is displayed on the display 112 of device 100.

FIGS. 5EC-5GU illustrate example user interfaces for navigation using a cover sheet in accordance with some embodiments. The user interfaces in these figures are used to illustrate the processes described below, including the processes in FIGS. 9A-9C. For convenience of explanation, some of the embodiments will be discussed with reference to operations performed on a device with a touch-sensitive display system 112. In such embodiments, the focus selector is, optionally: a respective finger or stylus contact, a representative point corresponding to a finger or stylus contact

(e.g., a centroid of a respective contact or a point associated with a respective contact), or a centroid of two or more contacts detected on the touch-sensitive display system 112. However, analogous operations are, optionally, performed on a device with a display 450 and a separate touch-sensitive surface 451 in response to detecting the contacts on the touch-sensitive surface 451 while displaying the user interfaces shown in the figures on the display 450, along with a focus selector.

FIGS. 5EC1 to 5EC4 illustrate activation of a display (e.g., touch-sensitive display 112) in response to changing an orientation of device 100. When the display has been activated, notifications that were received while the device was in a screen-off state were received. These notifications are displayed when the device transitions to a screen-on state. In FIG. 5EC1, the device is in a screen-off state while it is held flat in a user's hand 502, such that the device display is substantially horizontal. In FIG. 5EC2, the device is tilted such that the display is more vertical than in FIG. 5EC1. Because a tilt angle of the device has not increased above a threshold tilt angle in FIG. 5EC2, the display is not activated. In FIG. 5EC3, the device is tilted such that the display is more vertical than in FIG. 5EC2. Because a tilt angle of the device has increased above a threshold tilt angle in FIG. 5EC3, the display has transitioned from a screen-off state to a screen-on state and wake screen user interface 504 (also referred to herein as a cover sheet user interface 504) is displayed by the display 112. In FIG. 5EC4, the display 112 is substantially vertical.

FIG. 5ED illustrates a wake screen user interface 504, in accordance with some embodiments. Wake screen user interface 504 displays missed notification 5188 that was received and/or generated by device 100 (e.g., while device 100 was in a screen-off state). In some embodiments, wake screen user interface 504 additionally displays controls, such as a subset of controls from a control center user interface 5138 (e.g., a flashlight control 5190 and a camera control 5192).

In some embodiments, different input criteria must be met to activate a flashlight control 5190 when it is displayed on a wake screen user interface 504 and when it is displayed in a control center user interface 5138, as illustrated in FIGS. 5EE-5EJ and 5ET-5EW. Because wake screen user interface 504 may be displayed (e.g., in response to tilting the device) at a time when the user does not wish to provide input, more stringent criteria are applied for operating controls displayed on the wake screen user interface to prevent unintentional operation of the controls.

In some embodiments, input that has one effect when it is applied to a control (e.g., camera control 5192) when it is displayed in control center user interface 5138 has a different effect when the control is displayed in wake screen user interface 504. For example, a light press input on camera control 5192 causes a menu 5220 to be displayed when camera control 5192 is displayed in control center user interface 5138, and the light press input on camera control 5192 causes activation of a camera application when camera control 5192 is displayed in wake screen user interface 504, as illustrated by FIGS. 5EX-5FN.

In some embodiments, a time/date object 582 shifts horizontally as input for navigating from wake screen user interface 504 to adjacent user interfaces (control center user interface 5138 and widget user interface 5140) to indicate the direction of input needed to return to the wake screen user interface 504, as illustrate at FIGS. 5EJ-5EP and FIGS. 5EQ-5ES and 5FF-5FH. An overview of the arrangement

US 11,106,352 B2

49

wake screen user interface 504 to adjacent user interfaces control center user interface 5138 and widget user interface 5140 is shown in FIG. 5FR.

FIGS. 5EE-5EG illustrate a first flashlight activation input (e.g., a light press input) by a contact with touch screen 112, as indicated by focus selector 5194, at a location that corresponds to a flashlight control 5190 that is displayed on wake screen user interface 504. In FIG. 5EE, a characteristic intensity of the contact is above a detection threshold  $IT_o$ , as indicated by intensity level meter 5196, and below a light press intensity level  $IT_L$ . In FIG. 5EF, in accordance with a determination that a characteristic intensity of the contact has increased above a light press intensity threshold, as indicated by  $IT_L$  on intensity level meter 5196, a flashlight is activated, as indicated by flashlight beam 5198. In FIG. 5EG, the contact indicated by focus selector 5194 has lifted off of touch screen 112.

FIGS. 5EH-5EI illustrate a first flashlight deactivation input (e.g., a light press input) by a contact with touch screen 112 at a location that corresponds to flashlight control 5190, as indicated by focus selector 5200. In FIG. 5EI, in accordance with a determination that a characteristic intensity of the contact has increased above a light press intensity threshold, as indicated by  $IT_L$  on intensity level meter 5196 while the flashlight is on, the flashlight is shut off. In FIG. 5EJ, the contact indicated by focus selector 5200 has lifted off of touch screen 112.

FIGS. 5EK-5EL illustrate an input (e.g., a rightward swipe) that is initiated by a contact on touch screen 112, as indicated by focus selector 5202. In response to the input, wake screen user interface 504 slides to the right and mini application user interface 5140 is revealed, as shown in FIGS. 5EK-5EM. Mini application user interface 5140 displays mini application objects 583, 585, 587, and 589 that include a subset of content from application. As wake screen user interface 504 slides to the right, time/date object 582 moves from a position in the center of the display 112, as shown in FIG. 5EK, to a position at the right of the display 112, as shown in FIG. 5EM. Repositioning time/date object 582 provides a visual indication to the user of the direction of the swipe input needed to return to wake screen 504.

In some embodiments, a mini application object (e.g., as illustrated by mini application objects 583, 585, 587, and 589) is configured to perform a subset, less than all, of the functions of a corresponding application. In some embodiments, a mini application object displays an identifier for the corresponding application. In some embodiments, a mini application object displays a portion of the content the corresponding application. In some embodiments, a pre-defined input on a mini application object launches the corresponding application. In some embodiments, a mini application object operates as a standalone application residing in memory of the device, distinct from an associated application also residing in the memory of the device. For example, a mini application object corresponding to a social networking application operates as a single-purpose or streamlined application with a subset, less than all, of the functionality of the corresponding application, but is associated with the full-featured social networking application. In this example, the mini application object operates independently of the social networking application, and in a scenario where the social networking application is not running, the mini application object continues to operate. In some embodiments, a mini application object operates as an extension or component of an associated application on the device.

50

FIGS. 5EN-5EO illustrate an input (e.g., a leftward swipe) that is initiated by a contact on touch screen 112, as indicated by focus selector 5204. In response to the input, mini application user interface 5140 slides to the left and wake screen user interface 504 is revealed, as shown in FIG. 5EN-5EP. As mini application user interface 5140 slides to the left, time/date object 582 moves from a position in at the right of the display 112, as shown in FIG. 5EN, to a position in the center of the display 112, as shown in FIG. 5EP. Repositioning time/date object 582 provides a visual indication to the user of the direction of the swipe input needed to return to wake screen 504.

FIGS. 5EQ-5ER illustrate an input (e.g., a leftward swipe) that is initiated by a contact on touch screen 112, as indicated by focus selector 5206. In response to the input, wake screen user interface 504 slides to the left and control center user interface 5138 is revealed, as shown in FIG. 5EQ-5ES. As wake screen user interface 5140 slides to the left, time/date object 582 moves from a position in at the center of the display, as shown in FIG. 5EQ, to a position at the left of the display, as shown in FIG. 5ES. Repositioning time/date object 582 provides a visual indication to the user of the direction of the swipe input needed to return to wake screen 504.

FIG. 5ET illustrates a second flashlight activation input (e.g., a tap input) by a contact with touch screen 112, as indicated by focus selector 5208, at a location that corresponds to a flashlight control 5190 that is displayed on control center user interface 5138. In response to the input, a flashlight is activated, as indicated by flashlight beam 5210 in FIG. 5EU. Because a wake screen user interface 504 is displayed on waking the device (e.g., when the device is tilted as described with regard to FIGS. 5EC1-5EC4), input that meets threshold intensity criteria (e.g., light press intensity criteria) is needed to activate the flashlight using a flashlight control 5190 displayed in the wake screen user interface 504. In this way, accidental activation of the flashlight is avoided. When the user has provided input to navigate to control center user interface 5138, a tap input (as described with regard to FIGS. 5ET-5EU) is sufficient to activate the flashlight.

FIG. 5EV illustrates a second flashlight deactivation input (e.g., a tap input) by a contact with touch screen 112 at a location that corresponds to flashlight control 5190, as indicated by focus selector 5212. In response to the input, the flashlight is shut off, as indicated at FIG. 5EW.

FIG. 5EX illustrates a control center camera application activation input (e.g., a tap input) by a contact with touch screen 112, as indicated by focus selector 5214, at a location that corresponds to a camera control 5192 that is displayed on control center user interface 5138. In response to the control center camera application activation input, display of the control center user interface 5138 is replaced by display of a camera application user interface 5216, as shown in FIG. 5EY.

FIGS. 5EZ-5FB illustrate camera menu display input (e.g., a light press input) by a contact with touch screen 112, as indicated by focus selector 5218, at a location that corresponds to a camera control 5192 that is displayed on control center user interface 5138. In FIG. 5EA, a characteristic intensity of the contact is above a detection threshold  $IT_o$ , as indicated by intensity level meter 5196, and below a light press intensity level  $IT_L$ . In FIG. 5FB, in accordance with a determination that a characteristic intensity of the contact increases above a light press intensity threshold, as



## US 11,106,352 B2

51

indicated by  $IT_L$  on intensity level meter 5196, a camera menu 5220 is displayed overlaying control center user interface 5138.

In FIG. 5FC, the contact indicated by focus selector 5218 has lifted off from touch screen 112.

In FIG. 5FD, an input (e.g., a tap input) by a contact on touch screen 112 is detected at a location outside of camera menu 5220, as indicated by focus selector 5222. In response to the input, camera menu 5220 ceases to be displayed overlaying control center user interface 5138, as shown in FIG. 5FE.

FIGS. 5FF-5FG illustrate an input (e.g., a rightward swipe) that is initiated by a contact on touch screen 112, as indicated by focus selector 5224. In response to the input, control center user interface 5138 slides to the right and wake screen user interface 504 is redisplayed, as shown in FIGS. 5FG-5FH. As control center user interface 5138 slides to the right, time/date object 582 moves from a position in the left of the display, as shown in FIG. 5FF, to a position at the center of the display, as shown in FIG. 5FH.

FIG. 5FI illustrates an input (e.g., a tap input) by a contact with touch screen 112, as indicated by focus selector 5226, at a location that corresponds to a camera control 5192 that is displayed on wake screen user interface 504. As shown in FIGS. 5FI-5FJ, a tap input on camera control 5192 that is displayed on wake screen user interface 504 has no effect (unlike a tap input on camera control 5192 displayed in control center user interface 5138, which causes a camera application user interface 5216 to be displayed, as discussed with regard to FIGS. 5EX-5EY).

Whereas a light press input on a camera control displayed in control center user interface 5138 causes a camera menu 5220 to be displayed, a light press input on a camera control displayed in wake screen user interface 504 causes a camera application user interface 5216 to be displayed. FIGS. 5FK-5FL illustrate a wake screen camera activation input (e.g., a light press input) by a contact with touch screen 112, as indicated by focus selector 5228, at a location that corresponds to a camera control 5192 that is displayed on wake screen user interface 504. In FIGS. 5FK-5FL, a characteristic intensity of the contact is above a detection threshold  $IT_0$ , as indicated by intensity level meter 5196, and below a light press intensity level  $IT_L$ . In FIG. 5FM, in accordance with a determination that a characteristic intensity of the contact has increased above a light press intensity threshold, as indicated by  $IT_L$  on intensity level meter 5196, display of the wake screen user interface 504 is replaced by display of a camera application user interface 5216.

FIGS. 5FN-5FT illustrate that, in response to authentication input (e.g., as shown in FIG. 5FP, additional notification information is displayed on wake screen user interface 504.

FIG. 5FN illustrates an input (e.g., an upward swipe) by a contact on touch screen 112 that is initiated at a lower edge of touch screen 112, as indicated by focus selector 5230. In response to the input, in accordance with a determination that the device is locked, an authentication user interface 518 is displayed, as shown in FIG. 5FO.

In FIG. 5P, an authentication input (e.g., a tap input) by a contact on touch screen 112 is detected at a location within authentication user interface 518, as indicated by focus selector 5232. In response to the authentication input, the device is unlocked and home screen user interface 522 is displayed, as shown in FIG. 5FQ.

FIG. 5FR illustrates an input (e.g., a downward swipe) that is initiated by a contact at a location near the upper edge of touch screen 112, as indicated by focus selector 5232. In response to the input, wake screen user interface 504 slides

52

down from the upper edge of display 112, as shown in FIGS. 5FR-5FT. When wake screen user interface 504 is displayed while device 100 is unlocked, as shown in FIG. 5FT, notification 5188 is displayed with information (e.g., message text 5234 and an image 5236) that were not displayed while device 100 was locked (see, e.g., FIG. 5ED), and an additional notification 5190 is displayed.

FIG. 5FU illustrates an arrangement of wake screen user interface 504 and adjacent user interfaces control center user interface 5138 and widget user interface 5140. As discussed above with regard to FIGS. 5EK-5EP, a rightward swipe on wake screen user interface 504 causes widget user interface 5140 to be displayed, and a leftward swipe on widget user interface 5140 causes wake screen user interface 504 to be displayed. As discussed above with regard to FIGS. 5EQ-5ES and FIGS. 5FF-5FH, a leftward swipe on wake screen user interface 504 causes control center user interface 5138 to be displayed, and a rightward swipe on control center user interface 5138 causes wake screen user interface 504 to be displayed. An upward swipe on wake screen user interface 504 causes a previously displayed user interface (e.g., home screen user interface 522, an application user interface, or a settings user interface) to be displayed.

As illustrated in FIGS. 5FV-5GB, when input to display widget user interface 5140 or control center user interface 5138 is received, the state of a user interface that is adjacent to wake screen user interface 504 being displayed is not "sticky," in that when widget user interface 5140 or control center user interface 513 are displayed and subsequently dismissed, a subsequent downward swipe input from the upper edge of display 112 will cause wake screen user interface 504 (and not widget user interface 5140 or control center user interface 513) to be displayed.

FIGS. 5FV-5FW illustrate an input (e.g., a rightward swipe) that is initiated by a contact on touch screen 112, as indicated by focus selector 5238. In response to the input, wake screen user interface 504 slides to the right and mini application user interface 5140 is revealed, as shown in FIGS. 5FV-5FX.

FIG. 5FY illustrates an input (e.g., an upward swipe) by a contact on touch screen 112 that is initiated at a lower edge of touchscreen 112 by a contact at location that is indicated by focus selector 5240. In response to the input, display of mini application user interface 5140 is replaced by display of home screen user interface 522, as shown in FIGS. 5FY-5FZ.

In FIGS. 5FZ-5GB, after an input is received for navigation to a user interface that is adjacent to wake screen user interface 504 (e.g., to navigate to mini application user interface 5140 or control center user interface 5138) and a subsequent input is received to dismiss the user interface that is adjacent to wake screen user interface 504 (e.g., the input in FIG. 5FY to reveal home screen 522), a downward swipe reveals wake screen user interface 504 (and not the adjacent interface that was displayed prior to the dismissal input). For example, in FIG. 5FZ, an input (e.g., a downward swipe) is initiated by a contact at a location near the upper edge of touch screen 112, as indicated by focus selector 5242. In response to the input, wake screen user interface 504 (and not mini application user interface 5140) slides down from the upper edge of display 112, as shown in FIGS. 5FZ-5GB.

FIGS. 5GC-5GP illustrate input to display a maps application, activate a navigation mode of the maps application and display a navigation banner 5160, and transition the



## US 11,106,352 B2

53

navigation banner **5160** from a pill form, as shown in FIG. **5FM**, to a banner form, as shown in FIG. **5GP**, in accordance with some embodiments.

FIG. **5GC** illustrates an input (e.g., an upward swipe) by a contact on touch screen **112** that is initiated by a contact at location that corresponds to home affordance **552**, as indicated by focus selector **5244**. In response to the input, display of wake screen user interface **504** is replaced by display of home screen user interface **522**, as shown in FIGS. **5GC-5GD**.

In FIG. **5GE**, an input (e.g., a tap input) is detected at a location that corresponds to affordance **5248** for displaying a maps application interface, as indicated by focus selector **5246**. In response to the input, a maps application user interface **5154** is displayed, as shown in FIG. **5GF**.

In FIG. **5GH**, an input (e.g., a tap input) by a contact on touch screen **112** is detected at a location that corresponds to a control **5156** for activating a navigation mode of the maps application, as indicated by focus selector **5250**. In response to the input, the navigation mode of the maps application is initiated, and a navigation mode user interface is displayed in maps application user interface **5154**, as indicated at FIG. **5GI**.

FIG. **5GJ** illustrates an input (e.g., an upward swipe) by a contact on touch screen **112** that is initiated by a contact at location that corresponds to home affordance **552**, as indicated by focus selector **5252**. In response to the input, display of wake screen user interface **504** is replaced by display of home screen user interface **522**, as shown in FIGS. **5GK-5GL**. In FIG. **5GL**, a navigation banner **5160** is displayed in a pill format within home screen user interface **522**.

FIGS. **5GM-5GO** illustrate an input (e.g., a downward swipe) that is initiated by a contact at a location near the upper edge of touch screen **112**, as indicated by focus selector **5254**. In response to the input, wake screen user interface **504** slides down from the upper edge of display **112**, as shown in FIGS. **5GM-5GP**. As wake screen user interface **504** slides down, navigation banner **5160** transitions from a pill format, as shown in FIG. **5GM**, to a banner format, as shown in FIG. **5GP**. For example, as navigation banner **5160** gradually transitions from a pill format to a banner format, an animation is displayed in which navigation text **5178** is displayed in navigation banner **5160**, navigation direction arrow **5180** grows, navigation banner **5160** gradually grows and moves toward the center of display **112**, and time **5182** ceases to be displayed.

From FIG. **5GP** to FIG. **5GQ**, the information displayed in navigation banner **5160** has updated (e.g., in accordance with a changed location of the phone as the user proceeds along the navigation route), indicating that the content of navigation banner **5160** updates (e.g., in real time) while navigation banner **5160** is displayed.

FIG. **5GR** illustrates an input (e.g., an upward swipe) by a contact on touch screen **112** that is initiated at a location near the lower edge of touch screen **112**, as indicated by focus selector **5256**. In response to the input, wake screen user interface **504** slides up from the lower edge of display **112** to redisplay the underlying maps user interface **5154** (that was previously covered by wake screen user interface **504**).

FIG. **5GT** illustrates an input (e.g., an upward swipe) by a contact on touch screen **112** that is initiated by a contact at location that corresponds to home affordance **552**, as indicated by focus selector **5258**. In response to the input, display of wake screen user interface **504** is replaced by display of home screen user interface **522**, as shown in

54

FIGS. **5GT-5GU**. In FIG. **5GU**, because the navigation mode of maps application **5154** is still active, a navigation banner **5160** is displayed in a pill format within home screen user interface **522**.

From FIG. **5GL** to FIG. **5GU**, the information displayed in the pill format version of navigation banner **5160** has updated (e.g., in accordance with a changed location of the phone as the user proceeds along the navigation route), indicating that the content of the pill format version of navigation banner **5160** updates (e.g., in real time) while navigation banner **5160** is displayed.

In FIGS. **5GV-5GW**, the color of one or more objects on wake screen user interface **504** (e.g., time/date object **582**, navigation banner **5188**, notification **5188**, and/or notification **5234**) are altered in accordance with a change in a background color and/or image of wake screen user interface **504**.

FIGS. **5GX-5HR** illustrate a panel-based cover sheet user interface **5260** (e.g., a wake screen displayed on a device with a large format display, such as a tablet device). In some embodiments, when panel-based cover sheet user interface **5260** is dismissed and subsequently recalled, a state of the panel-based cover sheet user interface **5260** when panel-based cover sheet user interface **5260** is recalled is the same as the state of panel-based cover sheet user interface **5260** prior to the dismissal.

In FIG. **5GX**, panel-based cover sheet user interface **5260** is displayed on display **112**. A notification panel **5262** is displayed on panel-based cover sheet user interface **5260**.

FIGS. **5GY-5GZ** illustrate an input (e.g., a rightward swipe) that is initiated by a contact on touch screen **112**, as indicated by focus selector **5264**. In response to the input, notification panel **5262** slides to the right and a mini application panel **5266** is revealed, as shown in FIGS. **5GZ-5HA**. In FIG. **5HA**, notification panel **5262** and mini application panel **5266** are simultaneously displayed on panel-based cover sheet user interface **5260**.

FIGS. **5HB-5HC** illustrate an input (e.g., an upward swipe) by a contact on touch screen **112** that is initiated at a lower edge of touchscreen **112** by a contact at location that is indicated by focus selector **5268**. In response to the input, panel-based cover sheet user interface **5260** slides upward to reveal home screen user interface **522**, as shown in FIGS. **5HB-5HD**.

FIGS. **5RE-5HF** illustrate an input (e.g., a downward swipe) by a contact on touch screen **112** that is initiated at an upper edge of touchscreen **112** by a contact at location that is indicated by focus selector **5272**. In response to the input, panel-based cover sheet user interface **5272** slides downward over home screen user interface **522**, as shown in FIGS. **5HE-5HG**. Notification panel **5262** and mini application panel **5266**, which were simultaneously displayed on panel-based cover sheet user interface **5260** prior to dismissal of panel-based cover sheet user interface **5272**, continue to be displayed when panel-based cover sheet user interface **5260** is redisplayed.

FIGS. **5HH-5HI** illustrate an input (e.g., a leftward swipe) that is initiated by a contact on touch screen **112**, as indicated by focus selector **5274**. In response to the input, notification panel **5274** slides to the left, until notification panel **5274** ceases to be displayed, and a control center panel **5278** is revealed, as shown in FIGS. **5HH-5HL**. In FIG. **5HL**, notification panel **5262** and control center panel **5278** are simultaneously displayed on panel-based cover sheet user interface **5260**.

FIGS. **5HM-5HN** illustrate an input (e.g., an upward swipe) by a contact on touch screen **112** that is initiated at

## US 11,106,352 B2

55

a lower edge of touchscreen 112 by a contact at location that is indicated by focus selector 5278. In response to the input, panel-based cover sheet user interface 5260 slides upward to reveal home screen user interface 522, as shown in FIGS. 5HM-5HO.

FIGS. 5HP-5HF illustrate an input (e.g., a downward swipe) by a contact on touchscreen 112 that is initiated at an upper edge of touchscreen 112 by a contact at location that is indicated by focus selector 5280. In response to the input, panel-based cover sheet user interface 5272 slides downward over home screen user interface 522, as shown in FIGS. 5HP-5HR. Notification panel 5262 and control center panel 5278, which were simultaneously displayed on panel-based cover sheet user interface 5260 prior to dismissal of panel-based cover sheet user interface 5272, continue to be displayed when panel-based cover sheet user interface 5260 is redisplayed.

FIGS. 6A-6G are flow diagrams illustrating method 600 of clearing sets of notifications, in accordance with some embodiments. Method 600 is performed at an electronic device (e.g., device 300, FIG. 3, or portable multifunction device 100, FIG. 1A) with a display, a touch-sensitive surface, and one or more sensors to detect intensity of contacts with the touch-sensitive surface. In some embodiments, the display is a touch-screen display and the touch-sensitive surface is on or integrated with the display. In some embodiments, the display is separate from the touch-sensitive surface. Some operations in method 600 are, optionally, combined and/or the order of some operations is, optionally, changed.

As described below, method 600 provides an intuitive way to clear sets of notifications. The method reduces the number, extent, and/or nature of the inputs from a user when clearing sets of notifications, thereby creating a more efficient human-machine interface. For battery-operated electronic devices, enabling a user to clear sets of notifications faster and more efficiently conserves power and increases the time between battery charges.

While the device is in a screen-off state (e.g., as shown in FIGS. 5A1-5A2), the device receives (602) one or more notifications.

After receiving the one or more notifications (e.g., while the device remains in the screen-off state, or while the one or more notifications are displayed on a dark screen of the screen-off state), the device detects (604) a first input from a user for waking the device from the screen-off state to a screen-on state (e.g., the device detects a state change indicating that the device has been picked up, as described with regard to FIGS. 5A1-5A4, or the device detects an input at a control, such as push button 106, for waking the device).

In response to detecting the first input for waking the device from the screen-off state to the screen-on state, the device (606): transitions the device from the screen-off state to the screen-on state (e.g., as shown at FIGS. 5A2-5A3), displays a wake screen user interface 504 on the display 112 (as shown in FIGS. 5A3 and 5B), and displays the one or more notifications (e.g., notifications 506, 508, 510, and 512 shown in FIG. 5B) on the wake screen user interface 504 (e.g., the notifications are displayed as a list of notification banners below a time-date object 582). These notifications are sometimes also referred to as "missed notifications" because they were received while the device was in the screen-off state. In some embodiments, the wake screen user interface 504 is also a cover sheet user interface that is displayed to cover a currently displayed user interface when a downward edge swipe gesture (e.g., a downward swipe that starts from an upper edge of the touch-sensitive surface

56

112) is detected on the display 112. In some embodiments, the wake screen user interface 504 includes a time-date object 582 showing the current time and date, and/or one or more prompts or affordances for unlocking the device from a locked state to an unlocked state.

While displaying the wake screen user interface 504 and while at least one of the one or more notifications remains displayed on the wake screen user interface 504 (e.g., at a later time after the user has interacted with the device which may include interactions that cause the dismissal and then redisplay of the wake screen user interface one or more times), the device detects (608) a second input for dismissing the wake screen user interface (e.g., an upward swipe input to reveal an underlying user interface or an input (e.g., on a power button) to shut off the display).

In response to detecting the second input for dismissing the wake screen user interface, the device ceases (610) to display the wake screen user interface 504 and the at least one of the one or more notifications (e.g., notifications 506, 508, 510, and 512 shown in FIG. 5B). In some embodiments, the device reveals an underlying interface such as a home screen user interface 522, a settings user interface, or an application user interface (e.g., messages user interface 530, web browser user interface 540, music user interface 560, or maps user interface 5154).

After ceasing to display the wake screen user interface 504 and the at least one of the one or more notifications in response to the second input, the device detects (612) a third input for redisplaying the wake screen user interface (e.g., the third input may be an input for waking the device again after the device has transitioned back to the screen-off state, or an input (e.g., a downward swipe from the top of the touch-screen) for redisplaying the wake screen user interface after the wake screen user interface has been dismissed while the device remains in the screen-on state).

In response to detecting the third input for redisplaying the wake screen user interface 504 (614), in accordance with a determination that the third input meets notification-clearance criteria (e.g., notification-clearance criteria are criteria for completely removing all remaining missed notifications from the wake screen user interface and, optionally, deleting the notifications or saving them to notification history), the device redisplay the wake screen user interface 504 without displaying the at least one of the one or more notifications on the redisplayed wake screen user interface 504 (e.g., all previously displayed missed notifications are cleared from the wake screen user interface). The notification-clearance criteria require that the third input is detected at a time that is (1) after a respective notification of the one or more notifications has been cleared through direct user interaction with the respective notification or an application that corresponds to the respective notification and (2) after the device has transitioned from the screen-on state to the screen-off state at least once since the detection of the second input (e.g., since the last input for dismissing the wake screen user interface was detected). Examples of user interaction with the respective notification include an input to activate a displayed deletion control, such as an "x" icon displayed adjacent to the notification (e.g., a tap gesture by a contact at a location that corresponds to the displayed control), an input (such as a deep press or swipe gesture) on the notification to dismiss or delete the notification or to reveal a control for dismissing the notification followed by an input to activate a control for dismissing the notification, or an input to open the notification in an application (e.g., a tap gesture by a contact at a location that corresponds to the notification). For example, the input described with regard to



US 11,106,352 B2

57

FIGS. 5AV-5AW (e.g., the input to wake the device) is detected at a time that is detected at a time that is (1) after a respective notification of the one or more notifications has been cleared through direct user interaction with the respective notification or an application that corresponds to the respective notification (e.g., described with regard to FIGS. 5L-5P and FIGS. 5Y-5AC) and (2) after the device has transitioned from the screen-on state to the screen-off state at least once since the detection of the second input (e.g., as described with regard to FIGS. 5AU-5AW). In accordance with a determination that the third input does not meet the notification-clearance criteria: the device redisplay the wake screen user interface, and redisplay the at least one of the one or more notifications on the redisplayed wake screen user interface (e.g., continuing to display all of the notifications that were not dismissed by the user through direct user interaction (e.g., all or a subset of all the missed notifications that were received during the screen-off state)).

This heuristic allows a device to either automatically clear a set of missed notifications or to redisplay a set of missed notifications displayed on a wake screen depending on whether notification-clearance criteria are met. Automatically clearing a set of missed notifications in accordance with a determination that notification-clearance criteria are met makes the user-device interface more efficient and enhances the operability of the device by providing the user with the ability to clear multiple notifications without requiring the user to manually dismiss each notification, while retaining the ability of the user to individually clear missed notifications in the set of multiple notifications (e.g., by maintaining the device in a screen-on session while interacting with the individual notifications). Enabling the user to use the device more quickly and efficiently reduces power usage and improves battery life of the device.

In some embodiments, in response to detecting the third input for redisplaying the wake screen user interface, and in accordance with the determination that the third input does not meet the notification-clearance criteria (616), in accordance with a determination that one or more notification-clearance interactions have occurred (e.g., through a direct user interaction with a notification or interaction with an application that corresponds to a notification), the device forgoes display of one or more notifications that are cleared by the one or more notification-clearance interactions on the redisplayed wake screen user interface 504. For example, notification-clearance interactions are described with regard to FIGS. 5L-5P and FIGS. 5Y-5AC. In FIG. 5P, notification 510 is not displayed due to interaction with notification 510 that occurred in FIG. 5L (to cause display of messages application 530). In FIG. 5AC, notification 506 is not displayed due to the interaction with notification 506 that occurred in Figure AB (to cause deletion of the notification). In some embodiments, in accordance with a determination that no notification-clearance interactions have occurred, all of the one or more notifications are redisplayed on the redisplayed wake screen user interface.

Forgoing display of one or more notifications that are cleared by the one or more notification-clearance interactions on the redisplayed wake screen user interface reduces the amount of information displayed on the redisplayed wake screen. Reducing the amount of information displayed on the redisplayed wake screen makes the user-device interface more efficient and enhances the operability of the device by allowing a user to access notification information that the user has not previously reviewed without having to navigate past information that the user has previously reviewed.

58

In some embodiments, after detecting the first input for waking the device from the screen-off state to the screen-on state and prior to detecting the second input for dismissing the wake screen user interface (618), the device detects a plurality of intermediate inputs, the plurality of intermediate inputs including: a first intermediate input for dismissing the wake screen user interface (in response to which the wake screen is dismissed and a background user interface is revealed, or in response to which the device goes into the screen-off state and the screen is dark with no interface displayed), and a second intermediate input for redisplaying the wake screen user interface (in response to which the wake screen is redisplayed over a currently displayed user interface, or in response to which the device is woken to the screen-on state and the wake-screen user interface is displayed as soon as the display is turned on). For example, in FIGS. 5B-5C, the device transitions from a screen-on state to a screen-off state (e.g., in response to a user input to shut off the display), and at FIGS. 5C-5D, the device transitions back to a screen-on state (e.g., in response to a user input to wake the display). In FIGS. 5Q-5R, wake screen 504 is dismissed, and in FIGS. 5V-5X, wake screen 504 is redisplayed.

Maintaining display of a set of missed notifications after detecting intermediate inputs for dismissing and redisplaying a wake screen user interface makes the user-device interface more efficient and enhances the operability of the device by allowing a user to display the wake screen repeatedly (e.g., to view the time or check for an incoming notification) while maintaining a list of missed notifications for the user to handle when the user is ready to interact with the notifications (without requiring the user to provide input for redisplaying the missed notifications while the wake screen is displayed).

In some embodiments (620), the second input for dismissing the wake screen user interface is an input for displaying a first user interface (e.g., an application user interface such as messages user interface 530 or music user interface 560, a settings management user interface, a springboard user interface (home screen user interface 522) that includes a plurality of application launch icons, etc.) that is distinct from the wake screen user interface, the first user interface is displayed in response to the second input (e.g., after the wake screen user interface is dismissed, the first user interface is revealed from underneath the wake screen user interface), and the third input for redisplaying the wake screen user interface was received while the first user interface is displayed. For example, in FIGS. 5L-5M, an wake screen user interface 504 is dismissed in response to user input that causes messages user interface 530 to be displayed. While messages user interface 530 is displayed, input to redisplay wake screen user interface is received as described with regard to FIGS. 5N-5P.

Redisplaying the wake screen in response to input received while a first user interface (such as an application user interface, a springboard user interface, or a settings management user interface) is displayed allows a user to access the wake screen (and any missed notifications displayed on the wake screen) at all times while using the device. This makes the user-device interface more efficient and enhances the operability of the device by allowing a user to access the wake screen without requiring the user to navigate through multiple interfaces to gain access to the wake screen).

In some embodiments (622), the third input for redisplaying the wake screen user interface 504 is received while a content playback application is active (e.g., in response to an

US 11,106,352 B2

59

activation input as described with regard to FIG. 5AK), and redisplaying the wake screen user interface includes displaying (e.g., above the one or more missed notifications) at least one media playback control 572 (e.g., in a media playback control panel 568) in the wake screen user interface 504. In some embodiments, the playback controls are displayed on the wake screen user interface 504 whenever the wake screen user interface is displayed while the content playback application is active (e.g., media playback is ongoing).

Displaying at least one media playback control on the wake screen user interface (e.g., in addition to the time and/or missed notifications) while a content playback application is active allows a user to control playback via the displayed media playback control immediately upon waking the device, or by accessing the wake screen at any time while using the device. This makes the user-device interface more efficient and enhances the operability of the device by allowing a user to view the time and/or missed notifications while accessing the device to control media playback without needing to unlock the device and/or navigate through multiple interfaces.

In some embodiments, while the wake screen user interface 504 is displayed, the device detects (624) a fourth input by a contact on the touch-sensitive surface, including detecting movement of the contact along the touch-sensitive surface in a first direction (e.g., downwards) and detecting lift-off of the contact after the movement (e.g., as described with regard to FIGS. 5AW-5AZ). In response to detecting the fourth input, the device: moves at least one object (e.g., an object 582 that displays a current time and/or date) displayed on the wake screen user interface 504 (e.g., in the first direction) in accordance with the movement of the contact, and reverses the movement of the at least one object (e.g., moving in a second direction opposite the first direction, e.g., upwards) upon lift-off of the contact.

Providing visual feedback, such as a "rubber band effect" simulated by moving at least one object in accordance with movement of a contact and reversing the movement of the at least one object upon lift-off of the contact, enhances operability of the device by providing an intuitive indication to the user that the wake screen is responsive to input such as a swipe input) to view additional notifications and thereby helping the user to provide proper inputs to achieve a desired outcome. The indication is intuitive because the user receives the information without the need to display additional instruction to the user for understanding the feature).

In some embodiments, while displaying the one or more notifications on the wake screen user interface, the device detects (626) a fifth input by a contact on the touch-sensitive surface (e.g., a tap input) at a location that corresponds to a first notification of the one or more notifications. In response to detecting the fifth input, the device ceases to display the wake screen user interface and displays a first application user interface for a first application that corresponds to the first notification. For example, in FIG. 5L, an input at a location that corresponds to notification 510 is detected. In FIG. 5M, in response to the detected input, messages application user interface 530 is displayed.

Displaying an application user interface for an application that corresponds to a notification in response to input detected at a location that corresponds to the notification makes the user-device interface more efficient and enhances the operability of the device by allowing a user to interact with an application with minimal input immediately upon waking the device or otherwise accessing a missed notification on the wake screen user interface.

60

In some embodiments, while displaying the first application user interface for the first application that corresponds to the first notification (e.g., messages application user interface 530, as shown in FIGS. 5M-5N), the device detects (628) a sixth input for redisplaying the wake screen user interface (e.g., an input as described with regard to FIGS. 5N-5O). In response to detecting the sixth input for redisplaying the wake screen user interface, the device ceases to display the first application user interface (e.g., as shown in FIG. 5O), displays the wake screen user interface (e.g., as shown in FIG. 5P), displays at least one second notification of the one or more notifications on the wake screen user interface (e.g., notifications 506, 508, and 512), wherein the at least one second notification corresponds to a second application that is distinct from the first application, and forgoes display of the first notification (and, optionally, any other notifications among the one or more missed notifications that correspond to the first application) on the wake screen user interface 504 with the at least one second notification. For example, in FIG. 5P, notification 510 is no longer displayed.

Forgoing display of a notification on the wake screen user interface after displaying an application interface of an application that corresponds to the notification reduces the amount of information displayed on the redisplayed wake screen. Reducing the amount of information displayed on the redisplayed wake screen makes the user-device interface more efficient and enhances the operability of the device by allowing a user to access notification information that the user has not previously reviewed without having to navigate past information that the user has previously reviewed (e.g., when accessing an application interface for an application that corresponds to the notification).

In some embodiments, after detecting the sixth input, while displaying the wake screen user interface 504, the device detects (630) a seventh input for dismissing the wake screen user interface (e.g., including detecting an upward swipe gesture on the touch-sensitive surface). In response to detecting the seventh input for dismissing the wake screen user interface, the device ceases to display the wake screen user interface (e.g., by pulling the wake screen user interface 504, which is used as a "cover sheet" user interface, upward), and redisplay the first application user interface for the first application. For example, FIGS. 5Q-5R show an input that causes wake screen user interface 504 to slide up to reveal the underlying messages application user interface 530.

Redisplaying a last displayed user interface after dismissing the wake screen user interface allows the user to return to a previous operating context without requiring multiple inputs, thereby making the user-device interface more efficient (e.g., by reducing the number of inputs needed to return to a previously viewed user interface).

In some embodiments, while the first application user interface for the first application (e.g., messages user interface 530 for a messages application) is redisplayed, the device detects (632) an eighth input (e.g., as described with regard to FIGS. 5S-5T) for invoking a third application that is distinct from the first application and the second application. In response to detecting the eighth input for invoking the third application, the device displays a third application user interface of the third application (e.g., browser application user interface 540 for a web browser application). After detecting the eighth input, while displaying the third application user interface, the device detects a ninth input (e.g., as described with regard to FIG. 5V-5W) for redisplaying the wake screen user interface (e.g., including



US 11,106,352 B2

61

detecting a downward edge swipe gesture (e.g., a downward swipe that starts from an upper edge of the touch-sensitive surface 112)). In response to detecting the ninth input for redisplaying the wake screen user interface 504, the device ceases to display the third application user interface, displays the wake screen user interface 504 (e.g., pull down the wake screen user interface over the second application user interface), and redisplay the at least one second notification of the one or more notifications on the wake screen user interface without redisplaying the first notification (or, optionally, any missed notifications that correspond to the first application and the third application). For example, in FIG. 5X, wake screen 504 is displayed with notifications 506, 508, and 512.

Maintaining display of a set of missed notifications after detecting intermediate inputs for dismissing and redisplaying a wake screen user interface makes the user-device interface more efficient and enhances the operability of the device by allowing a user to display the wake screen repeatedly (e.g., to view the time or check for an incoming notification) while maintaining a list of missed notifications for the user to handle when the user is ready to interact with the notifications (without requiring the user to provide input for redisplaying the missed notifications while the wake screen is displayed).

In some embodiments, after displaying the at least one second notification without displaying the first notification on the wake screen user interface (e.g., in FIG. 5AU, notifications 508 and 512 are displayed and notifications 506 and 510 are no longer displayed), the device detects (634) a first transition from the screen-on state to the screen-off state (e.g., the transition is triggered when an amount of time that has passed since a last input was received increased above a threshold time, or when an input is received at a control for shutting off the display) followed by a second transition from the screen-off state to the screen-on state (e.g., when an input is received to wake the device or turn on the display). For example, FIGS. 5AU-5AV illustrate a transition from the screen-on state to the screen-off state and FIGS. 5AV-5AW illustrate a transition from the screen-off state to the screen-on state. In response to detecting the first transition followed by the second transition: the device redisplay the wake screen user interface without displaying any of the one or more notifications on the wake screen user interface (e.g., the notification-clearance criteria are met, and all of the missed notifications that were still remaining on the wake screen are now cleared). For example, in FIG. 5AW, no notifications are displayed.

Automatically clearing a set of missed notifications in accordance with a determination that notification-clearance criteria are met makes the user-device interface more efficient and enhances the operability of the device by providing the user with the ability to clear multiple notifications without requiring the user to manually dismiss each notification. Enabling the user to use the device more quickly and efficiently reduces power usage and improves battery life of the device.

In some embodiments, while displaying the wake screen user interface with all of the one or more notifications (e.g., before the user interacted with one of the notifications or opened an application that corresponds to one of the one or more notifications), the device detects (636) a third transitioning from the screen-on state to the screen-off state (e.g., the transition is triggered when an amount of time that has passed since a last input was received increased above a threshold time, or when an input is received at a control for shutting off the display) followed by a fourth transition from

62

the screen-off state to the screen-on state (e.g., when an input is received to wake the device or turn on the display). For example, a transition from the screen-on state to the screen-off state is shown in FIGS. 5B-5C and a transition from the screen-off state to the screen-on state is shown in FIGS. 5C-5D. In response to detecting the third transition followed by the fourth transition, the device redisplay the wake screen user interface with the one or more notifications on the wake screen user interface (e.g., all of the missed notifications still remain on the wake screen). For example, in FIG. 5D, all of the notifications 506-512 displayed in FIG. 5B are redisplayed.

Maintaining display of a set of missed notifications after a transition from the screen-on state to the screen-off state followed by a transition from the screen-off state to the screen-on state makes the user-device interface more efficient and enhances the operability of the device by allowing a user to display the wake screen repeatedly (e.g., to view the time or check for an incoming notification) while maintaining a list of missed notifications for the user to handle when the user is ready to interact with the notifications (without requiring the user to provide input for redisplaying the missed notifications while the wake screen is displayed).

In some embodiments, while displaying the wake screen user interface with the one or more notifications, the device detects (638) a tenth input (e.g., an upward swipe gesture on the touch-sensitive surface) for displaying an authentication user interface 518 (e.g., including a password input prompt, such as a number pad). In response to detecting the tenth input for displaying the authentication user interface: the device ceases to display the wake screen user interface 504 and displays the authentication user interface 518. For example, in response to an input described with regard to FIG. 5E, authentication user interface 518 is displayed in FIG. 5F. While the authentication user interface 518 is displayed, the device detects an authorization input (e.g., a passcode entered via the number pad). In accordance with a determination that the authorization input is valid, the device displays a second user interface (e.g., an application user interface, a settings user interface, or a home screen user interface). For example, in response to detecting the authorization input shown in FIG. 5G, home screen user interface 522 is displayed in FIG. 5H. While displaying the second user interface, the device detects an eleventh input for redisplaying the wake screen user interface 504 (e.g., detecting a downward swipe gesture on the touch-sensitive surface (e.g., a downward swipe gesture that started from the top edge of the touch-sensitive surface)). In response to detecting the eleventh input, the device ceases to display the second application user interface; and redisplay the wake screen user interface with the one or more notifications. For example, an input for redisplaying wake screen user interface 504 received while home screen user interface 522 is displayed is shown in FIGS. 5I-5J. In some embodiments, in accordance with a determination that the authorization input is not valid, the second user interface is not displayed and/or the user is prompted for additional authorization input. In some embodiments, the authentication is automatically performed, and detecting an upward swipe gesture dismisses the wake screen user interface and reveals the last active user interface prior to the device's transition from the screen-on state to the screen-off state, or the last active user interface prior to the device's transition from the unlocked state to the locked state.

Maintaining display of a set of missed notifications after detecting intermediate inputs for dismissing and redisplaying a wake screen user interface makes the user-device

US 11,106,352 B2

63

interface more efficient and enhances the operability of the device by allowing a user to display the wake screen repeatedly (e.g., to view the time or check for an incoming notification) while maintaining a list of missed notifications for the user to handle when the user is ready to interact with the notifications (without requiring the user to provide input for redisplaying the missed notifications while the wake screen is displayed).

In some embodiments, in accordance with the determination that the third input meets the notification-clearance criteria, the device adds (640), to a set of recent notifications, one or more cleared notifications that correspond to the at least one of the one or more notifications not displayed on the wake screen user interface. In some embodiments, when the notification-clearance criteria are met, all of the missed notifications are cleared from the wake screen user interface/cover sheet user interface, and are added to a list of recent notifications. In some embodiments, when a missed notification is individually cleared by direct user interaction with that notification, that notification is added to the list of recent notifications.

Adding a cleared notification to a set of recent notifications makes the cleared notification available for future user access. Making a cleared notification available for future user access makes the user-device interface more efficient by allowing a user to view notification content associated with multiple applications without individually accessing each application).

In some embodiments, after adding the one or more cleared notifications to the set of recent notifications, while the wake screen user interface is displayed, the device detects (642) a twelfth input (e.g., an upward swipe on the touch-screen that pulls on a currently displayed notification, or an input on a control for revealing recent notifications). In response to detecting the twelfth input, in accordance with a determination that the twelfth input meets recent-notification-display criteria, the device displays at least a portion of the set of recent notifications (e.g., overlaid on the wake screen user interface). For example, in FIGS. 5BJ-5BO, notifications 506-512, that were cleared as discussed with regard to 5A-5AW, are redisplayed in response to an input that meets recent-notification-display criteria.

Displaying notifications from a set of recent notifications in response to input on the wake screen user interface allows a user to view a sequential list of notification content (e.g., including notifications that were previously cleared). Allowing a user to view a sequential list of notification content received by the device makes the user-device interface more efficient by allowing a user to view notification content associated with multiple applications without individually accessing each application).

It should be understood that the particular order in which the operations in FIGS. 6A-6G have been described is merely an example and is not intended to indicate that the described order is the only order in which the operations could be performed. One of ordinary skill in the art would recognize various ways to reorder the operations described herein. Additionally, it should be noted that details of other processes described herein with respect to other methods described herein (e.g., methods 700, 800, and 900) are also applicable in an analogous manner to method 600 described above with respect to FIGS. 6A-6G. For example, the contacts, gestures, user interface objects, tactile outputs, focus selectors, and animations described above with reference to method 600 optionally have one or more of the characteristics of the contacts, gestures, user interface objects, tactile outputs, focus selectors, and animations

64

described herein with reference to other methods described herein (e.g., methods 700, 800, and 900). For brevity, these details are not repeated here.

The operations described above with reference to FIGS. 6A-6G are, optionally, implemented by components depicted in FIGS. 1A-1B. For example, receiving operation 602, detection operation 604, transitioning operation 606, and displaying operation 606, are, optionally, implemented by event sorter 170, event recognizer 180, and event handler 190. Event monitor 171 in event sorter 170 detects a contact on touch-sensitive display 112, and event dispatcher module 174 delivers the event information to application 136-1. A respective event recognizer 180 of application 136-1 compares the event information to respective event definitions 186, and determines whether a first contact at a first location on the touch-sensitive surface (or whether rotation of the device) corresponds to a predefined event or sub-event, such as selection of an object on a user interface, or rotation of the device from one orientation to another. When a respective predefined event or sub-event is detected, event recognizer 180 activates an event handler 190 associated with the detection of the event or sub-event. Event handler 190 optionally uses or calls data updater 176 or object updater 177 to update the application internal state 192. In some embodiments, event handler 190 accesses a respective GUI updater 178 to update what is displayed by the application. Similarly, it would be clear to a person having ordinary skill in the art how other processes can be implemented based on the components depicted in FIGS. 1A-1B.

FIGS. 7A-7E are flow diagrams illustrating method 700 of displaying notification history in accordance with some embodiments. Method 700 is performed at an electronic device (e.g., device 300, FIG. 3, or portable multifunction device 100, FIG. 1A) with a display, a touch-sensitive surface, and one or more sensors to detect intensity of contacts with the touch-sensitive surface. In some embodiments, the display is a touch-screen display and the touch-sensitive surface is on or integrated with the display. In some embodiments, the display is separate from the touch-sensitive surface. Some operations in method 700 are, optionally, combined and/or the order of some operations is, optionally, changed.

As described below, method 700 provides an intuitive way to display a notification history. The method reduces the number, extent, and/or nature of the inputs from a user when displaying a notification history, thereby creating a more efficient human-machine interface. For battery-operated electronic devices, enabling a user to display a notification history faster and more efficiently conserves power and increases the time between battery charges.

The device displays (702), on display 112, a first user interface, including displaying one or more missed notifications in a first scrollable arrangement (e.g., a first scrollable list) on the first user interface. For example, in FIG. 5BA, notifications 586, 588, 590, and 592 are displayed on wake screen user interface 504. In some embodiments, the first user interface is a wake screen user interface 504 that is displayed upon the display transitioning from a display-off state to a display-on state (e.g., in response to detecting an input or event that wakes the device from the display-off state, such as a sleep state or other power-saving or inactive state). For example, FIGS. 5A1-5A4 show the display transitioning from a display-off state to a display-on state. In some embodiments, the first user interface is a cover sheet user interface (also depicted as 504) that is displayed to cover a currently displayed user interface when a downward edge swipe gesture (e.g., a downward swipe that starts from



## US 11,106,352 B2

65

an upper edge of the touch-sensitive surface) is detected on the display. In some embodiments, the cover sheet user interface is also the wake screen user interface that is displayed when the device transitions from the screen-off state to the screen-on state.

While displaying the first user interface with the one or more missed notifications, the device detects (704) a first swipe gesture (e.g., as shown in FIGS. 5BF-5BG), including detecting a first contact at a location on the touch-sensitive surface that corresponds to the first scrollable arrangement (e.g., as indicated by region 5100), and detecting first movement of the first contact across the touch-sensitive surface in a first direction (e.g., upward).

In response to detecting the first swipe gesture, the device scrolls (706) the first scrollable arrangement in accordance with the first movement of the first contact (e.g., notifications 586-592 move upward in response to the input illustrated at FIGS. 5BF-5BG).

After scrolling the first scrollable arrangement in accordance with the first movement of the first contact, the device detects (708) a second swipe gesture, including detecting a second contact at a location on the touch-sensitive surface that corresponds to the first scrollable arrangement and detecting second movement of the second contact across the touch-sensitive surface in the first direction (e.g., as shown in FIGS. 5BI-5BN).

In response to detecting the second swipe gesture (710): in accordance with a determination that the second movement of the second contact meets notification-history-display criteria, the device displays a plurality of previously received notifications that are distinct from the one or more missed notifications in a second scrollable arrangement on the first user interface (e.g., the device displays previously received notifications 506-512, which are distinct from missed notifications 586-592). The notification-history-display criteria require (1) that the second movement of the second contact is detected after an end (e.g., a bottommost missed notification 5102) of the first scrollable arrangement has been reached in accordance with the first movement of the first contact and (2) that the second movement exceeds a first threshold amount of movement (e.g., as indicated at 5108) in the first direction. In accordance with the determination that the second movement of the first contact does not meet the notification-history-display criteria, the device forgoes displaying the plurality of previously received notifications (and, optionally, continuing to scroll the first scrollable arrangement in accordance with the second movement of the second contact).

This method relates to a way to combine the functions of a wake screen user interface and a notification history screen into a wake screen user interface. The wake screen user interface displays missed notifications, and in response to specific inputs notification history is displayed in the wake screen user interface as well. Displaying previously received notifications in accordance with a determination that movement of a contact meets notification history display criteria allows a user to view a sequential list notification content received by the device (e.g., including notifications that were previously cleared). The notifications in the second scrollable arrangement remain undisplayed when swipe input does not meet the notification-history-display criteria, so that the user does not unintentionally reveal previously cleared notifications. Allowing a user to view a sequential list of notification content received by the device makes the user-device interface more efficient by allowing a user to view notification content associated with multiple applications without individually accessing each application. Leav-

66

ing the notifications in the second scrollable arrangement undisplayed when swipe input does not meet the notification-history-display criteria allows the user to navigate among the missed notifications in the first scrollable arrangement without unintentionally viewing previously cleared notifications.

In some embodiments (712), the first user interface is a wake screen user interface 504, and the first user interface is displayed immediately upon waking the device from the display-off state to the display-on state. For example, FIGS. 5A1-5A4 show display of a wake screen user interface 504 when device 100 transitions from a display-off state to a display-on state.

In some embodiments, while displaying the one or more missed notifications in the first scrollable arrangement on the first user interface, the device detects (714) a missed notification dismissal input for dismissing a respective notification of the one or more missed notifications in the first scrollable arrangement. For example, input to dismiss notification 592 is illustrated in FIGS. 5BV-5BY. A dismissal input for dismissing a respective notification is, e.g., an input to activate a displayed control (e.g., a tap gesture by a contact at a location that corresponds to the displayed control) for dismissing the notification; an input (such as a deep press or swipe gesture) on the notification to dismiss the notification, or to reveal a control for dismissing the notification followed by an input to activate a control for dismissing the notification, or an input to open the notification in an application (e.g., a tap gesture by a contact at a location that corresponds to the notification)). After detecting the missed notification dismissal input for dismissing the respective notification, the device ceases to display the respective notification of the one or more notifications on the first user interface, and adds the respective notification to the plurality of previously received notifications. For example, if the wake screen is displayed again without the respective notification, and a swipe gesture that meets notification-history-display criteria is detected on the first scroll arrangement including the remaining missed notifications, the respective notification is displayed among the plurality of previously received notifications in the second scrollable arrangement.

Ceasing to display a notification after detecting a missed notification dismissal input for dismissing the notification reduces the number of notifications displayed on the first user interface after the user has provided input that indicates the notification has been viewed and/or handled by the user. Reducing the number of notifications displayed on the first user interface makes the user-device interface more efficient by allowing a user to more quickly locate and address notifications that have not been previously viewed and/or handled by the user.

In some embodiments, while the first user interface is displayed, the device detects (716) a third swipe gesture (e.g., as shown at FIGS. 5BB-5BC), including detecting a third contact at a location on the touch-sensitive surface that corresponds the first scrollable arrangement and detecting third movement of the third contact across the touch-sensitive surface in a second direction that is distinct from the first direction (e.g., downwards). In response to detecting the third swipe gesture, the device translates the first scrollable arrangement (and optionally, at least one object (e.g., an object that displays a current time and/or date)) in accordance with the third movement of the third contact (e.g., translating the first scrollable arrangement relative to other objects currently displayed on the first user interface in the downward direction, or translating the first user interface

US 11,106,352 B2

67

as a whole in the downward direction to display an extension of the first user interface at the top that was not displayed prior to detecting the third swipe gesture). For example, notifications 586-592 move downward in accordance with the movement of the input shown in FIGS. 5BB-5BC. The device detects lift-off of the third contact from the touch-sensitive surface (e.g., the touch-screen display) after detecting the third movement (e.g., the contact indicated by focus selector 594 in FIG. 5BC has lifted off of touch screen 112, as shown in FIG. 5BD). In response to detecting the liftoff of the third contact, the device reverses the translation of the first scrollable arrangement that was made in accordance with the third movement of the third contact (e.g., restoring the position of the first scrollable arrangement relative to the other objects currently displayed on the first user interface, or restoring the first user interface as a whole and ceasing to display the extension of the first user interface at the top). As shown in FIGS. 5BD-5BE, in response to the liftoff that occurred, the notifications move 586-592 upward.

Providing visual feedback, such as a “rubber band effect” simulated by translating the scrollable arrangement of missed notifications in accordance with movement of a contact and reversing the translation of the scrollable arrangement upon lift-off of the contact, enhances operability of the device by providing an intuitive indication to the user that the first user interface is responsive to input (such as a swipe input) to view additional notifications.

In some embodiments, while displaying the plurality of previously received notifications in the second scrollable arrangement on the first user interface, the device detects (718) a fourth swipe gesture (e.g., as shown at FIG. 5CA), including detecting a fourth contact at a location on the touch-sensitive surface that corresponds to the second scrollable arrangement (e.g., notifications 506-512) and detecting fourth movement of the fourth contact across the touch-sensitive surface in a second direction opposite the first direction (e.g., the fourth swipe gesture is a downward swipe gesture directed to the second scrollable arrangement). In response to detecting the fourth swipe gesture, in accordance with a determination that the fourth movement of the fourth contact meets notification-history-dismissal criteria, the device ceases to display the plurality of previously received notifications on the first user interface. In some embodiments, the notification-history-dismissal criteria require (1) that the fourth movement of the fourth contact is detected after an end (e.g., an uppermost notification) of the second scrollable arrangement has been reached and (2) that the fourth movement exceeds a second threshold amount of movement in the second direction opposite the first direction. In accordance with the determination that the fourth movement of the fourth contact does not meet the notification-history-dismissal criteria, the device scrolls the plurality of previously received notifications in the second scrollable arrangement in accordance with the fourth movement of the fourth contact. In some embodiments, scrolling the plurality of previously received notifications in the second scrollable arrangement causes at least one of the one or more missed notifications in the first scrollable arrangement to be revealed (e.g., if the at least one of the one or more missed notifications in the first scrollable arrangement was scrolled beyond the edge of the display in response to the first swipe gesture and/or the second swipe gesture). In some embodiments, scrolling previously received notifications causes missed notifications in the first scrollable arrangement to be revealed (e.g., as shown in FIGS. 5BT-5BU), allowing a user to navigate between notifications that have been cleared and notifications that have not yet been cleared for a comprehensive

68

view of notifications that have been received by the device. Providing the user with a comprehensive view of notifications that have been received by the device makes the user-device interface more efficient by allowing a user to view recent notification content without needing to individually access each application for which the content was received and/or generated.

Scrolling through the notification history or dismissing the notification history based on the same swipe gesture in accordance with whether the notification-history-dismissal criteria are met enhances the operability of the user interface and makes the user-device interface more efficient (e.g., by performing different functions based on whether predefined conditions are met), which additionally improves the battery life of the device.

In some embodiments, while displaying the first user interface, the device detects (720) a first user interface dismissal input for input (e.g., as shown at FIG. 5CO) for dismissing the first user interface (e.g., a swipe gesture, including fifth movement of a fifth contact from a location that corresponds to an edge of the display (such as a location that is at or proximate to the bottom edge of the display) across the touch-sensitive surface in the first direction (e.g., upward from the bottom edge of the display). In response to detecting the first user interface dismissal input, the device ceases to display the first user interface (e.g., along with any missed notifications and/or recent notifications that are currently displayed on the first user interface), and, in some embodiments, the device reveals an underlying interface such as a home screen user interface 522, a settings user interface, or an application user interface. For example, in FIGS. 5CO-5CQ, home screen user interface 522 is revealed in response to an input for dismissing wake screen user interface 504.

In some embodiments, the device includes one or more tactile output generators (722), and while the first user interface is displayed, in accordance with the determination that the second movement of the second contact meets the notification-history-display criteria (e.g., as described with regard to FIG. 5BK), the device generates, with the one or more tactile output generators, a tactile output (e.g., tactile output 5112) to indicate that the criteria for displaying the plurality of previously received notifications have been met.

Generating a tactile output to indicate that criteria for displaying the plurality of previously received notifications have been met provides the user with feedback about the input that is required to meet notification-history-display criteria. Providing the user with feedback about the input that is required to meet notification-history-display criteria makes the user-device interface more efficient (e.g., by helping the user to provide proper inputs and reducing user mistakes when operating/interacting with the device) which, additionally, reduces power usage and improves battery life of the device by enabling the user to use the device more quickly and efficiently.

In some embodiments (724), the first contact moves with a first rate of movement during the first swipe gesture, scrolling the first scrollable arrangement occurs at a first scroll rate that corresponds to the first rate of movement by the first contact (e.g., the scroll rate matches the first rate of movement); the second contact moves with a second rate of movement during the second swipe gesture; and displaying the plurality of previously received notifications in the second scrollable arrangement includes scrolling a first previously received notification of the plurality of previously received notifications in the second scrollable arrangement at a second scroll rate that is greater than the second



US 11,106,352 B2

69

rate of movement by the second contact (e.g., to provide an appearance of the previously received notifications in the second scrollable arrangement “catching up” with the second contact). For example, as the contact indicated by focus selector **5106** moves along touch screen **112** as shown in FIGS. **5B1-5B9**, missed notifications **586-592** in a first scrollable arrangement move at the rate of movement of the contact, and, in FIGS. **5B1-5B9**, previously received notifications **506-512** in a second scrollable arrangement move faster than the rate of movement of the contact. In some embodiments, a second previously received notification of the plurality of previously received notifications is scrolled at a third scroll rate that is distinct from the second scroll rate.

Scrolling a first previously received notification of the plurality of previously received notifications in the second scrollable arrangement at a second scroll rate that is greater than the second rate of movement by the second contact provides the user with visual feedback about the input that is required to meet notification-history-display criteria (e.g., by giving the user of a sense of the notifications in the second scrollable arrangement “racing to catch up” with the second contact when the criteria are met). Providing the user with feedback about the input that is required to meet notification-history-display criteria makes the user-device interface more efficient (e.g., by helping the user to provide proper inputs and reducing user mistakes when operating/interacting with the device) which, additionally, reduces power usage and improves battery life of the device by enabling the user to use the device more quickly and efficiently.

In some embodiments, the device detects (**726**) a fifth swipe gesture, including detecting a fifth contact at a first location on the touch-sensitive surface and detecting fifth movement of the fifth contact across the touch-sensitive surface in a third direction that is perpendicular to the first direction (e.g., leftward or rightward). In response to detecting the fifth swipe gesture, in accordance with a determination that the first location on the touch-sensitive surface corresponds to a first notification among the one or more missed notifications or the plurality of previously received notifications, the device moves the first notification in accordance with the movement of the fifth contact (e.g., the input shown in FIG. **5BV-5BW** drags notification **592**). In accordance with a determination that the first location on the touch-sensitive surface corresponds to a location outside of the first scrollable arrangement and the second scrollable arrangement, the device replaces display of the first user interface with display of a second user interface (e.g., a control center user interface **5138** or mini application user interface **5140**). For example, FIGS. **5CC-5CE** illustrate a swipe gesture by contact at a location outside of the first scrollable arrangement and the second scrollable arrangement that causes control center user interface **5138** to be displayed, and FIGS. **5CI-5CK** illustrate a swipe gesture by contact at a location outside of the first scrollable arrangement and the second scrollable arrangement that causes mini application user interface **5140** to be displayed.

This heuristic allows a swipe gesture (e.g., a horizontal swipe gesture) to have different responses depending on whether the gesture corresponds to a missed notification or corresponds to a location outside of scrollable arrangements of missed notifications. This heuristic enhances operability of the device by providing different responses to the same gesture depending on the location of the gesture rather than requiring the device to provide a different gesture type (in

70

turn requiring the user to learn the additional gesture type) to obtain the different responses.

In some embodiments, the device detects (**728**) that criteria for dismissing all of the one or more missed notifications in the first scrollable arrangement are met (e.g., via one or more inputs that include user interaction with all of the missed notifications, via one or more inputs for accessing one or more applications associated with the missed notifications, and/or by satisfying notification clearance criteria that require input that is received at a time that is (1) after a respective notification of the one or more notifications has been cleared through direct user interaction with the respective notification or an application that corresponds to the respective notification and (2) after the device has transitioned from the screen-on state to the screen-off state at least once since the last direct user interaction that dismissed a respective notification). In response to detecting that the criteria for dismissing all of the one or more missed notifications are met, the device adds, to the plurality of previously received notifications, all of the one or more missed notifications (and forgoing displaying those one or more missed notifications the next time that the first user interface is displayed). For example, in FIG. **5CS**, all notifications have been cleared (e.g., as a result of input as shown at FIGS. **5BV-5BZ** and FIGS. **5CQ-5CS**). In FIG. **5CX**, in response to input shown in **5CW**, notifications **586-592** that had been cleared and added to the plurality of previously received notifications are redisplayed.

In some embodiments, while displaying the first user interface without any missed notifications (e.g., after detecting that the criteria for dismissing all of the one or more missed notifications in the first scrollable arrangement have been met and adding the one or more missed notifications to the plurality of previously received notifications), the device detects (**730**) a sixth swipe gesture (e.g., as shown in FIG. **5CW**), including a sixth contact at a location on the touch-sensitive surface that corresponds to the location at which the first scrollable arrangement was previously displayed, and the device detects sixth movement of the sixth contact across the touch-sensitive surface in the first direction. In response to detecting the sixth swipe gesture: in accordance with a determination that the sixth movement of the sixth contact exceeds the first threshold amount of movement in the first direction, the device displays the plurality of previously received notifications (including the one or more missed notifications that were dismissed and added to the plurality of previously received notifications). For example, in FIG. **5CX**, in response to input shown in **5CW**, notifications **586-592** are redisplayed. In accordance with the determination that the sixth movement of the sixth contact does not exceed the first threshold amount of movement in the first direction, the device forgoes displaying the plurality of previously received notifications.

Displaying a plurality of previously received notifications after displaying the first user interface without any missed notifications allows a user to recall missed notifications (e.g., even after providing input to clear all missed notifications). Enabling the user to recall the missed notifications makes the user-device interface more efficient and by allowing the user to view content received and/or generated by the device without needing to access multiple applications. Additionally, a user can provide input to clear notifications with the knowledge that the notification will be recoverable if the user subsequently wishes to view the notification content.

In some embodiments, while the first user interface is displayed without any missed notifications (e.g., after

## US 11,106,352 B2

71

detecting that the criteria for dismissing all of the one or more missed notifications in the first scrollable arrangement have been met and adding the one or more missed notifications to the plurality of previously received notifications), the device detects (732) a seventh swipe gesture (e.g., as shown at FIGS. 5CS-5CT), including detecting a seventh contact at a location on the touch-sensitive surface that corresponds to the location at which the first scrollable arrangement was previously displayed and detecting seventh movement of the seventh contact across the touch-sensitive surface in a second direction opposite the first direction (e.g., downward). In response to detecting the seventh swipe gesture, the device translates at least one object (e.g., an object 582 that displays a current time and/or date) displayed on the first user interface in the second direction in accordance with the seventh movement of the seventh contact. After translating the at least one object, the device detects lift-off of the seventh contact (e.g., as shown at FIG. 5CU). In response to detecting liftoff of the seventh contact from the touch-sensitive surface, the device reverses the translation of the at least one object that have been made in accordance with the seventh movement of the seventh contact.

Providing visual feedback, such as a “rubber band effect” simulated by translating at least one object in accordance with movement of a contact and reversing the translation of the at least one object upon lift-off of the contact, enhances operability of the device by providing an intuitive indication to the user that the wake screen is responsive to input (such as a swipe input) to view notifications (e.g., even when the user is viewing a first user interface that does not include display of any missed notifications).

It should be understood that the particular order in which the operations in FIGS. 7A-7E have been described is merely an example and is not intended to indicate that the described order is the only order in which the operations could be performed. One of ordinary skill in the art would recognize various ways to reorder the operations described herein. Additionally, it should be noted that details of other processes described herein with respect to other methods described herein (e.g., methods 600, 800, and 900) are also applicable in an analogous manner to method 700 described above with respect to FIGS. 7A-7E. For example, the contacts, gestures, user interface objects, tactile outputs, focus selectors, and animations described above with reference to method xxx optionally have one or more of the characteristics of the contacts, gestures, user interface objects, tactile outputs, focus selectors, and animations described herein with reference to other methods described herein (e.g., methods 600, 800, and 900). For brevity, these details are not repeated here.

The operations described above with reference to FIGS. 7A-7E are, optionally, implemented by components depicted in FIGS. 1A-1B. For example, display operation 702, detection operation 704, and scrolling operation 706 are, optionally, implemented by event sorter 170, event recognizer 180, and event handler 190. Event monitor 171 in event sorter 170 detects a contact on touch-sensitive display 112, and event dispatcher module 174 delivers the event information to application 136-1. A respective event recognizer 180 of application 136-1 compares the event information to respective event definitions 186, and determines whether a first contact at a first location on the touch-sensitive surface (or whether rotation of the device) corresponds to a predefined event or sub-event, such as selection of an object on a user interface, or rotation of the device from one orientation to another. When a respective pre-

72

defined event or sub-event is detected, event recognizer 180 activates an event handler 190 associated with the detection of the event or sub-event. Event handler 190 optionally uses or calls data updater 176 or object updater 177 to update the application internal state 192. In some embodiments, event handler 190 accesses a respective GUI updater 178 to update what is displayed by the application. Similarly, it would be clear to a person having ordinary skill in the art how other processes can be implemented based on the components depicted in FIGS. 1A-1B.

FIGS. 8A-8C are flow diagrams illustrating method 800 of displaying updating information from an application using a floating banner in accordance with some embodiments. Method 800 is performed at an electronic device (e.g., device 300, FIG. 3, or portable multifunction device 100, FIG. 1A) with a display, a touch-sensitive surface, and one or more sensors to detect intensity of contacts with the touch-sensitive surface. In some embodiments, the display is a touch-screen display and the touch-sensitive surface is on or integrated with the display. In some embodiments, the display is separate from the touch-sensitive surface. Some operations in method 800 are, optionally, combined and/or the order of some operations is, optionally, changed.

As described below, method 800 provides an intuitive way to display updating information from an application in a floating banner. The method reduces the number, extent, and/or nature of the inputs from a user when accessing information that is displayed in the floating banner, thereby creating a more efficient human-machine interface. For battery-operated electronic devices, displaying updating information from an application in floating banner that is visible in various operating contexts allows the user to operate the device faster and more efficiently, which conserves power and increases the time between battery charges.

The device displays (802) a first user interface (e.g., an application user interface, a home screen user interface, a lock screen user interface, etc.) on the display. For example, in FIG. 5DA, the device displays a map application user interface 5154.

The device displays (804) a first user interface object overlaid on a first portion of the first user interface (e.g., the device displays a banner object, such as navigation banner 5160, overlaid on a user interface of an application, such as map application user interface 5154), where the banner object is initially stationary relative to the user interface of the application. In some embodiments, the first user interface object is displayed when a persistent banner display mode of an application is active. In some embodiments, persistent banner display modes include a navigation mode of a maps application, and the first user interface object is a banner that includes navigation information, such as text and/or an icon indicating information associated with a next step in a navigation sequence (e.g., navigation information includes navigation text 5178 and navigation direction image 5180, as shown in FIG. 5DT). In some embodiments, persistent banner display modes include a content playback mode of a media application, and the first user interface object is a banner that includes media playback information, such as text and/or an image that correspond to a playing content item and/or one or more playback controls (see, e.g., media banner 568 shown in FIG. 5AO). In some embodiments, persistent banner display modes include a telephone call session of a telephone application, and the first user interface object is a banner that includes text with information about the call in progress, such as elapsed time and/or



## US 11,106,352 B2

73

contact information. In some embodiments, the first user interface object is a notification.

While displaying the first user interface object overlaid on the first portion of the first user interface, the device detects (806) a first input (e.g., a downward swipe input from an upper edge of the display 112, as shown at FIG. 5DB) for displaying a cover sheet user interface 504. In some embodiments, the cover sheet user interface 504 is also a wake screen user interface that is displayed when the device transitions from a screen-off state to a screen-on state. The cover sheet user interface 504 includes a first content object (e.g., one or more missed notifications, such as missed notifications 5164 and 5168 shown in FIG. 5DD) and a second content object (e.g., a time-date object 582 that displays a current time and date) displayed on a background object (e.g., a cover sheet platter or substrate with a pre-defined background).

In response to detecting the first input for displaying the cover sheet user interface 504, the device moves (808) the cover sheet user interface 504 across the display in a first direction (e.g., downward). For example, cover sheet user interface 504 slides down over map application user interface 5154, as shown at FIGS. 5DC-5DD. Moving the cover sheet user interface 504 across the display in a first direction includes moving the background object 5163 of the cover sheet user interface 504 across the display (e.g., to obscure an increasing portion of the first user interface without obscuring the first user interface object that is overlaid on the first user interface). In some embodiments, the background object 5163 of the cover sheet user interface slides onto the display in a z-layer that is located between the z-layer of the first user interface and the z-layer of the first user interface object.

Many electronic devices display user interface objects that have a layer order (i.e., a z-order or front-to-back order of the user interface objects). A user typically interacts with such objects by repositioning them on the display, and overlapping objects are displayed on the display in accordance with their front-to-back order (e.g., an object that is "in front" of another object is displayed where the two objects overlap). As used in the specification, a "layer order" is the front-to-back order of objects in a user interface (e.g., in an electronic document). Thus, if two objects overlap, the object that is higher in the layer order (e.g., the object that is "on top of" or "in front of") is displayed at any points where the two objects overlap, thereby partially obscuring the object that is lower in the layer order (e.g., the object that is "beneath" or "behind" or "in back of" the other object).

In accordance with a determination that the first user interface object has not reached a predefined threshold position relative to the cover sheet user interface (e.g., relative to a position between the first content object (e.g., missed notifications 5164 and/or 5168) and the second content object (e.g., time/date object 582) in the cover sheet user interface 504), the device moves the first content object and the second content object (e.g., in unison) with the background object 5163 while maintaining a current position of the first user interface object (e.g., navigation banner 5160) on the display (e.g., as shown in FIGS. 5DC-5DD). In accordance with a determination that the first user interface object (e.g., navigation banner 5160) has reached the predefined threshold position relative to the cover sheet user interface, the device moves the first user interface object (e.g., in unison) with the background object (e.g., as shown in FIGS. 5DD-5DE). In some embodiments, the device also moves the first content object (e.g., missed notifications 5164 and 5168), the second content object (e.g., time/date

74

object 582), and the first user interface object (e.g., navigation banner 5160) in unison with the background object 5163. For example, in FIG. 5DD, the time/date object 582 catches the banner object 5160 on its way down and pushes the banner object downward with the time/date object.

Method 800 relates to combining display of a user interface object that is overlaid on an initial user interface (e.g., a home screen user interface) with a newly displayed user interface (e.g., a cover sheet user interface). Specifically, some of the objects on the newly displayed user interface move past the first user interface object, while other objects on the newly displayed user interface "catches" the first user interface object and pushes it to its final position on the newly displayed user interface. This heuristic brings attention to the first user interface object (e.g., a banner object) by moving or not moving the first user interface object with the background object depending on whether the first user interface object has reached a predefined threshold position relative to a cover sheet interface. Bringing attention to the first user interface object improves the user-device interface, e.g., by helping the user to understand the connection between the banner content and the application from which the banner content originated. Displaying the banner improves the operability of the device by allowing the user to view content from an application without needing to navigate to the application, reducing the number of inputs required from the user to obtain banner content (e.g., navigation information).

In some embodiments, moving the cover sheet user interface 504 across the display in the first direction includes (810), in accordance with a determination that the second content object (e.g., the time and date object 582) has reached a first predefined location (e.g., the default position for the time and date on the display when the cover sheet is fully displayed) on the display, ceasing to move the second content object (e.g., the time and date 582) and the first user interface object (e.g., the banner 5160) and continuing to move the first content object (the one or more missed notifications) in the first direction (e.g., to make room for the banner object 5160 between the top missed notifications (e.g., notifications 5164 and 5168) and the current time and date object 582. For example, as cover sheet user interface 504 slides down in FIGS. 5DC-5DE, time/date object 582 and the navigation banner 5160 stop moving in FIG. 5DE, while missed notifications 5164 and 5168 continue to move downward in FIGS. 5DE-5DF.

Ceasing to move some of the content object while continuing to move other content objects on the cover sheet user interface allows the cover sheet user interface to be rearranged to accommodate the first user interface object (e.g., the banner), while providing visual continuity to the user, thereby reducing user mistakes when operating the device and enhance the operability of the device.

In some embodiments, the device ceases (812) to continue to move the first content object (e.g., the one or more missed notifications) in the first direction in accordance with a determination that the first content object has reached a second predefined location on the display (e.g., ceasing to move the missed notifications once the missed notifications have completely moved past the banner object).

Continuing to move the content objects on the cover sheet user interface until they reach their final locations allows the cover sheet user interface to be rearranged to accommodate the first user interface object (e.g., the banner), while providing visual continuity to the user, thereby reducing user mistakes when operating the device and enhance the operability of the device.

## US 11,106,352 B2

75

In some embodiments, the device transitions (814) from a screen-on state (as shown in FIG. 5DY) to a screen-off state (as shown in FIG. 5DZ) in accordance with a determination that display shutoff criteria are met (e.g., a power button is pressed or a period of user inactivity is detected). While the display is in the screen-off state, the device displays the first user interface object (e.g., the banner 5160) on a dark screen corresponding to the screen-off state (e.g., in accordance with a determination that an application associated with the first user interface object is in a persistent banner display mode, such as a navigation mode of a map application, a playback mode of a media application, or a call mode of a phone application). For example, in FIG. 5DZ, navigation banner 5160 is displayed on an otherwise dark display 112.

Displaying a first user interface object (e.g., a banner) when the device is in a screen-off state (e.g., displaying the first user interface object on an otherwise dark screen or on a screen that displays only one or more received notifications in addition to the first user interface object) provides the user with high priority information (e.g., navigation information) while the display forgoes displaying other content. Displaying the first user interface object (and/or the one or more missed notifications) while forgoing display of other content makes the user-device interface more efficient by reducing the amount of power required for the display. Additionally, displaying the first user interface object (and/or the one or more missed notifications) while forgoing display of other content eliminates the need for the user to wake the display from a screen-off state to display the first user interface object.

In some embodiments, while the display is in the screen-off state and the first user interface object is displayed on the display, the device receives (816) one or more notifications and, in response to receiving the one or more notifications, the device displays the first user interface object (e.g., the banner) and a third content object (e.g., the one or more notifications) on the first user interface (e.g., the one or more missed notifications are displayed under the first user interface object). For example, in FIG. 5EA, the device displays banner 5160 and missed notification 5186 on otherwise dark display 112. In some embodiments, while the display is in the screen-off state, the device detects a notification event and displays a notification object (e.g., for a new notification) under the banner. In some embodiments, one or more previously received notifications are displayed on the display (e.g., under the banner and/or above the new notification) while the display is in the screen-off state.

Displaying one or more received notifications when the device is in a screen-off state (e.g., displaying the one or more received notifications on an otherwise dark screen or on a screen that displays only a first user interface object in addition to the one or more received notifications) provides the user with high priority information (e.g., navigation information) while the display forgoes displaying other content. Displaying the one or more received notifications (and/or the first user interface object) while forgoing display of other content makes the user-device interface more efficient by reducing the amount of power required for the display. Additionally, displaying the one or more missed notifications (and/or the first user interface object) while forgoing display of other content eliminates the need for the user to wake the display from a screen-off state to display the one or more missed notifications.

In some embodiments, the device transitions (818) the device from a screen-off state to a screen-on state (e.g., as shown in FIGS. 5A1-5A3 and 5EA-5EB) in accordance with

76

a determination that display-waking criteria are met (e.g., a power button is pressed or the device orientation is changed in a certain way (e.g., picked up by a user), or a notification event is detected). In response to transitioning the device from the screen-off state to the screen-on state, the device displays the first user interface object (and no other objects) on a dark screen that corresponds to the display-off state. For example, in FIG. 5DZ, navigation banner 5160 is displayed on an otherwise dark display 112.

Displaying a first user interface object (e.g., a banner) when the device is in a screen-off state (e.g., displaying the first user interface object on an otherwise dark screen or on a screen that displays only one or more received notifications in addition to the first user interface object) provides the user with high priority information (e.g., navigation information) while the display forgoes displaying other content. Displaying the first user interface object (and/or the one or more missed notifications) while forgoing display of other content makes the user-device interface more efficient by reducing the amount of power required for the display. Additionally, displaying the first user interface object (and/or the one or more missed notifications) while forgoing display of other content eliminates the need for the user to wake the display from a screen-off state to display the first user interface object.

In some embodiments, while the cover sheet interface is displayed, the device detects (820) a third input (e.g., as shown at FIGS. 5DQ-5DR) for dismissing the cover sheet user interface 504. The third input includes a swipe gesture by a contact on the touch-sensitive surface (e.g., an upward swipe that started from the bottom edge of the touch-screen). In response to detecting the third input for dismissing the cover sheet user interface, the device ceases to display the cover sheet user interface 504, maintains display of the first user interface object (e.g., navigation banner 5160), and displays a home screen user interface 522. The first user interface object is overlaid on the home screen user interface. For example, in response to detecting an upward swipe gesture from the bottom edge of the touch-screen (e.g., as shown in FIGS. 5DQ-5DR), the cover sheet user interface 504 slides upward to reveal the home screen interface 522 underneath, while the first user interface (e.g., navigation banner 5160) remains stationary in a display layer above the cover sheet user interface 504, and appears overlaid on the home screen user interface 522 after the cover sheet user interface 504 is completely removed from view. In some embodiments, instead of the home screen user interface 522, a user interface of an application is displayed when the input for dismissing the cover sheet user interface 504 is detected, and the first user interface object is overlaid on the user interface of the application.

Displaying the first user interface object (e.g., a banner, such as navigation banner 5160) overlaid on the home screen makes the user-device interface more efficient by allowing the user to view the first user interface object after accessing the home screen without needing to navigate from the home screen to the application that generated the content of the first user interface object.

In some embodiments, while displaying the first user interface object overlaid on the home screen user interface (or a user interface of an application), the device detects (822) an input for minimizing the first user interface object (e.g., an upward swipe gesture on the banner, as shown at FIG. 5DT). In response to detecting the input for minimizing the first user interface object, the device transitions the first user interface object (e.g., banner mode of navigation banner 5160, as shown in FIG. 5DT) into a second user interface



object (e.g., a “pill” that has a smaller area than the first user interface object, as shown at **5160** FIG. 5DW). The first user interface object has a first size and the second user interface object has a second size that is smaller than the first size. In some embodiments, the second user interface object pulsates or blinks (e.g., at least a portion of the pill, such as the background of the pill, periodically changes color and/or size over time) to indicate that an application mode or process associated with the banner object is still active. In some embodiments, the second user interface object displays at least a portion of information displayed by the first user interface object. For example, in FIG. 5DT, navigation banner **5160** in banner mode displays navigation direction arrow **5180**, which is also displayed in the pill mode of navigation banner **5160** in FIG. 5DW. In some embodiments, the device displays an animated transition showing the banner shrinking and morphing into the “pill” while moving and settling into a upper corner of the touch-screen (e.g., as shown at FIGS. 5DT-5DW). In some embodiments, the second user interface object (e.g., navigation banner **5160** in pill form) displays media playback information (e.g., a play/pause toggle control). In some embodiments, the second user interface object displays information (e.g., a turn icon) associated with a navigation instruction.

Transitioning the first user interface object into a second user interface object in response to detecting input for minimizing the first user interface object makes the user-device interface more efficient by allowing the user to simultaneously view content of the home screen user interface that would otherwise be covered by the first user interface object and information from the first user interface object that is contained in the second user interface object (e.g., without needing to navigate from the home screen to the application that generated the content of the first user interface object).

In some embodiments, while the second user interface object is displayed, the device determines (**824**) that the display shutoff criteria are met. In response to determining that the display shutoff criteria are met, the device transitions the device from the screen-on state to a screen-off state, transitions the second user interface object into the first user interface object; and displays the first user interface object overlaid a dark screen corresponding to the screen-off state (e.g., a direct transition from FIG. 5DX to FIG. 5DZ).

Transitioning the second user interface object into a first user interface object in response to determining that display shutoff criteria are met provides the user with a larger object for increased visibility when the device is likely to be distant from the user (e.g., on a table or in a car rather than in the user’s hand). Providing the user with a larger object for increased visibility reduces power usage and improves battery life by providing information without requiring the user to wake the device and/or navigate to an application that generated the content of the first user interface object.

In some embodiments, while the second user interface object is displayed, the device detects (**826**) an input for activating the second user interface object (e.g., a tap input on the second user interface object). For example, in FIG. 5DX, an input is detected at a location corresponding to navigation banner **5160** in pill form, as indicated by focus selector **5160** in FIG. 5DX. In response to detecting the input for activating the second user interface object, the device displays an application user interface of an application that corresponds to the second user interface object. For example, in response to the input described with regard to FIG. 5DX, map application **5154** is displayed, as shown in FIG. 5DY.

Displaying an application user interface of an application that corresponds to the second user interface object in response to detecting input for activating the second user interface object provides the user with direct access to an application that corresponds to the second user interface object (e.g., the user can access the application that corresponds to the second user interface object from any page of a multi-page home screen without needing to provide input to navigate to an application launch icon on a different page of the home screen, within a folder on the home screen, etc.). This makes the user-device interface more efficient and enhances the operability of the device by reducing the number of inputs required to access an application user interface of an application that corresponds to the second user interface object.

In some embodiments, while the first user interface object is displayed (e.g., overlaid over the first user interface or overlaid over the cover sheet user interface **504**), the device detects (**828**) an input that activates the first user interface object (e.g., a tap input on the first user interface object). For example, in FIG. 5DH, an input, as indicated by focus selector **5168**, is detected at a location that corresponds to the navigation object **5160** displayed overlaid over cover sheet user interface **504**. In response to detecting the input that activates the first user interface object, the device displays the application user interface of the application that corresponds to the information displayed in the first user interface object. For example, in response to the input, maps application **5154** is displayed, as shown in FIG. 5DI.

In some embodiments, the application that corresponds to the second user interface object is an application that also corresponds to the first user interface object.

Displaying an application user interface of an application that corresponds to the first user interface object in response to detecting input for activating the first user interface object provides the user with direct access to an application that corresponds to the first user interface object (e.g., the user can access the application that corresponds to the first user interface object directly from the first user interface or the cover sheet user interface without providing input to navigate to the home screen.) This makes the user-device interface more efficient and enhances the operability of the device by reducing the number of inputs required to access an application user interface of an application that corresponds to the first user interface object.

It should be understood that the particular order in which the operations in FIGS. 8A-8C have been described is merely an example and is not intended to indicate that the described order is the only order in which the operations could be performed. One of ordinary skill in the art would recognize various ways to reorder the operations described herein. Additionally, it should be noted that details of other processes described herein with respect to other methods described herein (e.g., **600**, **700**, and **900**) are also applicable in an analogous manner to method **800** described above with respect to FIGS. 8A-8C. For example, the contacts, gestures, user interface objects, focus selectors, animations described above with reference to method xxx optionally have one or more of the characteristics of the contacts, gestures, user interface objects, focus selectors, animations described herein with reference to other methods described herein (e.g., methods **600**, **700**, and **900**). For brevity, these details are not repeated here.

The operations described above with reference to FIGS. 8A-8C are, optionally, implemented by components depicted in FIGS. 1A-1B. For example, display operation **802**, detection operation **806**, and object moving operation

808 are, optionally, implemented by event sorter 170, event recognizer 180, and event handler 190. Event monitor 171 in event sorter 170 detects a contact on touch-sensitive display 112, and event dispatcher module 174 delivers the event information to application 136-1. A respective event recognizer 180 of application 136-1 compares the event information to respective event definitions 186, and determines whether a first contact at a first location on the touch-sensitive surface (or whether rotation of the device) corresponds to a predefined event or sub-event, such as selection of an object on a user interface, or rotation of the device from one orientation to another. When a respective predefined event or sub-event is detected, event recognizer 180 activates an event handler 190 associated with the detection of the event or sub-event. Event handler 190 optionally uses or calls data updater 176 or object updater 177 to update the application internal state 192. In some embodiments, event handler 190 accesses a respective GUI updater 178 to update what is displayed by the application. Similarly, it would be clear to a person having ordinary skill in the art how other processes can be implemented based on the components depicted in FIGS. 1A-1B.

FIGS. 9A-9C are flow diagrams illustrating method 900 of navigation using a cover sheet, in accordance with some embodiments. Method 900 is performed at an electronic device (e.g., device 300, FIG. 3, or portable multifunction device 100, FIG. 1A) with a display, a touch-sensitive surface, and one or more sensors to detect intensity of contacts with the touch-sensitive surface. In some embodiments, the display is a touch-screen display and the touch-sensitive surface is on or integrated with the display. In some embodiments, the display is separate from the touch-sensitive surface. Some operations in method 800 are, optionally, combined and/or the order of some operations is, optionally, changed.

As described below, method 900 provides an intuitive way to navigate using a cover sheet. The method reduces the number, extent, and/or nature of the inputs from a user for accessing various controls that are available from user interfaces that are accessible via input provided at the cover sheet, thereby creating a more efficient human-machine interface. For battery-operated electronic devices, enabling a user to navigate using a cover sheet faster and more efficiently conserves power and increases the time between battery charges.

While the device is in a screen-off state, the device detects (902) a first input for waking the device from the screen-off state to a screen-on state (e.g., the device detects a state change indicating that the device has been picked up, as described with regard to FIGS. 5EC1-5EC4, or the device detects an input at a control, such as push button 106, for waking the device).

In response to detecting the first input for waking the device from the screen-off state to the screen-on state, the device transitions (904) the device from the screen-off state to the screen-on state (e.g., as shown at FIGS. 5EC2-5EC3), and displays a wake screen user interface 504 on the display 112. In some embodiments, the wake screen user interface 504 is redisplayed as a cover sheet user interface that covers an existing user interface in response to a cover sheet call-up command, and re-reveals the existing user interface that was covered by the cover sheet user interface in response to a cover-sheet dismissal command.

While displaying the wake screen user interface, the device detects (906) a first swipe gesture on the touch-sensitive surface 112 (e.g., a swipe gesture as shown at FIGS. 5EK-5EL or a swipe gesture as shown at FIGS.

5EQ-5ER), including detecting a first contact on the touch-sensitive surface and detecting movement of the first contact across the touch-sensitive surface.

In response to detecting the first swipe gesture, the device (908) ceases to display the wake screen user interface 504 and displays a first user interface. In accordance with a determination that the first swipe gesture is in a first direction (e.g., rightward, as shown in FIGS. 5EK-5EL), the displayed first user interface is a mini-application-object user interface 5140. The mini-application-object user interface 5140 includes one or more mini-application objects (e.g., mini-application objects 583, 585, 587, and 589) that each provide a subset of functions of a corresponding application without launching the corresponding application. In accordance with a determination that the first swipe gesture is in a second direction (e.g., leftward, as shown in FIGS. 5EQ-5ER), that is opposite the first direction, the displayed first user interface is a control panel user interface 5138. The control panel user interface 5138 includes one or more device controls (e.g., flashlight control 5190 and camera control 5192) for controlling one or more device functions of the device.

The wake screen user interface 504 has a fixed positional relationship relative to the mini-application-object screen 5140 and the control panel user interface 5138. Allowing the user to use directional gestures to navigate to either the mini-application-object screen or the control panel user interface enhances the operability of the device (e.g., by reducing the number of controls displayed on a wake screen user interface) and makes the user-device interface more efficient (e.g., by reducing visual clutter and reducing user mistakes due to the visual clutter), which, additionally, improves the battery life of the device.

In some embodiments, while the wake screen user interface 504 is displayed, the device displays (910) one or more notifications (e.g., notification 5188, as shown in FIG. 5ED) on the wake screen user interface. The device detects a second input for transitioning the device from an unauthenticated state to an authenticated state (e.g., as described with regard to FIGS. 5FN-5FQ). In response to detecting the second input, the device displays, on the wake screen user interface 504, restricted notification information corresponding to at least one of the one or more notifications. For example, as shown in FIG. 5FT, an additional notification 5234 is displayed and notification 5188 displays text 5234 and image 5236 that were not displayed prior to authentication. In some embodiments, restricted notification information is, e.g., notification content and/or other notification information that is subject to restricted access by a setting, such as a privacy and/or security setting of the device. In some embodiments, the restricted notification information includes one or more notifications that are not displayed when the device is in an unauthenticated state, such as notifications from one or more applications with settings that restrict display of notifications when the device is in an unauthenticated state. In some embodiments, the restricted notification information includes contextual information, such as earlier communication content in a notification and/or calendar information for a range of time that corresponds to a time associated with a calendar appointment notification. In some embodiments, when the device is in the unlocked mode of the display-on state, the second user interface includes longer versions of the notifications that are shown in the second user interface when the device is in the locked mode of the display-on state. The longer version of a notification includes expanded notification content that, for example, includes all of the content in the short version



US 11,106,352 B2

81

or standard version of the notification, and some additional content that is not included in the short version or standard version of the notification. In some embodiments, the expanded notification content includes more complete versions of the notification content shown in the short version of the notification. In some embodiments, the expanded notification content includes images, interactive controls, and/or selectable options for performing actions with respect to the notification, that are not included in the short versions of the notification.

Displaying restricted notification information in response to detecting a second input for transitioning the device from an unauthenticated state to an authenticated state allows the device to provide a user with an indication that a notification was received without disclosing full notification information to unauthenticated individuals able to view the device display. This makes the user-device interface more efficient and enhances the operability of the device by allowing a user to view information about incoming notifications without needing to wake the device (e.g., without jeopardizing the privacy of the notification content).

In some embodiments, while displaying the first user interface in response to the first swipe gesture, the device detects (912) a second swipe gesture (e.g., as shown in FIG. 5FN and or as shown in FIG. 5GC) in a third direction (e.g., upward, such as upward from a location proximate to the lower edge of the display) that is perpendicular to the first direction and the second direction. In accordance with a determination that the device is in an unauthenticated state, the device displays an authentication user interface 518, as shown at FIG. 5FO. In accordance with a determination that the device is in an authenticated state, the device displays a second user interface. The second user interface is a last displayed user interface that was displayed prior to the display of the wake screen user interface (e.g., either a home screen user interface or a user interface of an application). For example, FIG. 5GC is displayed when home screen user interface 522 was the last displayed user interface before wake screen user interface 504 was displayed, so in response to the swipe input illustrated at FIG. 5GC, home screen user interface 522 is redisplayed, as shown in FIG. 5GD. In some embodiments if the home screen user interface 522 was the last displayed user interface before the wake screen user interface 504 was displayed, then a swipe up from the control center user interface 5138 or mini application user interface 5140 reveals the home screen user interface 522 and if an application user interface (e.g., map application user interface 5154) was the last displayed user interface before the wake screen user interface 504 was displayed, then the swipe up reveals the application user interface. In some embodiments, the wake screen user interface 504 is displayed immediately upon waking the device, before authentication is made, and when authentication fails. In some embodiments, an indicator (e.g., an open lock icon and/or text indicating an unlocked state) is displayed briefly on the wake screen upon authentication. In some embodiments, an indicator changes state (e.g., a lock icon changes state from a closed lock icon to an open lock icon) in accordance with a determination that authentication has been successfully performed.

Redisplaying a last displayed user interface after dismissing the first user interface (e.g., the wake screen user interface/cover sheet user interface) enhances the operability of the device by reducing the number of steps needed to navigate back to the previous user interface, and the consistent behavior also reduces user mistakes which makes the user-device interface more efficient.

82

In some embodiments, in accordance with a determination that the second user interface is a home screen user interface 522, the device displays (914), in the home screen user interface, an object (e.g., navigation banner 5160) that displays content from a first active application (e.g., an application that has updating content, such as an application that last had focus and includes updating content, or an application that has a highest priority among multiple applications that includes updating content). In accordance with a determination that a state of the first active application has changed, the device updates the content displayed in the object in accordance with the changed state of the first active application. For example, navigation content shown in navigation object 5160 (shown in pill form in FIGS. 5GM and 5GU) updates (e.g., in accordance with a determined change in location of the device). In some embodiments, navigation content shown in navigation object 5160 (shown in banner form in FIGS. 5GP-5GQ) updates (e.g., in accordance with a determined change in location of the device). In some embodiments, the object also includes a region 5182 that displays a current time. In some embodiments, the object on the home screen user interface 522 is a "pill" (e.g., an object having a pill shape). In some embodiments, the object on the home screen user interface 522 is displayed in a region of the device display that is beyond a main display area (e.g., a rectangular display area) of the display. In some embodiments, the object displays live directions from a maps application operating in navigation mode. In some embodiments, the object displays live playback information from a media player application operating in playback mode. In some embodiments, the object displays live recording information from a screen recording or video recording application operating in recording mode. In some embodiments, the object corresponding to the first active application is also displayed when a user interface of a second active application distinct from the first active application is the currently displayed user interface.

Updating the content displayed in an object in the home screen user interface in accordance with a changed state of an active application provides information to a user from an active application without displaying the full application user interface. This makes the user-device interface more efficient by allowing a user to determine that an application is operating in an active mode without providing input to navigate from the home screen to the application user interface.

In some embodiments, while displaying the second user interface in response to the second swipe gesture, the device detects (916) a third swipe gesture (e.g., as shown at FIG. 5FR) in a fourth direction (e.g., downward) that is opposite the third direction; and in response to detecting the third swipe gesture in the fourth direction, the device ceases to display the second user interface (e.g., home screen user interface 522) and redisplay the wake screen user interface 504 (e.g., as shown in FIGS. 5FR-5FT).

In some embodiments, the control center user interface 5138 is displayed in response to a left swipe on the wake screen user interface 504 (e.g., as shown at FIGS. 5EQ-5ES) both when the wake screen user interface 504 is first displayed on waking the device, and when the wake screen user interface 504 is subsequently redisplayed (e.g., as a cover sheet layer over an application user interface or over a home screen user interface). In some embodiments, the mini-application-object user interface 5140 is displayed in response to a right swipe on the wake screen user interface 504 (e.g., as shown at FIGS. 5EK-5EM) both when the wake screen user interface 504 is first displayed, and when the

wake screen user interface 504 is subsequently redisplayed. In some embodiments, as the third swipe gesture in the fourth direction is received, the object on the home screen (the "pill") morphs into a second affordance (a floating banner) that is displayed on the wake screen user interface 504 (e.g., as shown by navigation banner 5160 in FIGS. 5GM-5GP). The morphing includes, e.g., a change in the size of the object, addition of content to the object (e.g., a direction icon 5180 and/or text), and/or removal of content (e.g., a time 5182) from the object.

Redisplaying the first user interface from any user interface (e.g., the home screen user interface or an application user interface) using the same gesture enhances the operability of the device (e.g., by reducing the number of steps needed to navigate to the first user interface), and makes the user-device interface more efficient (e.g., by providing a consistent way to bring about the first user interface and thereby reducing user mistakes).

In some embodiments, the wake screen user interface is displayed (918) with an affordance (e.g., a navigation banner 5160) that displays content from a second active application (e.g., an application, that is the same as the first active application or distinct from the first active application, that has updating content (such as an application that last had focus and includes updating content, or an application that has a highest priority among multiple applications that includes updating content)). For example, navigation banner 5160 shown in FIG. 5GP-5GQ includes updating content from maps application 5154. While displaying the wake screen user interface 504 with the affordance, in accordance with a determination that a state of the second active application has changed (e.g., a location of the device has changed, requiring an updated navigation instruction), the device updates the content displayed in the affordance in accordance with the changed state of the second active application (as indicated by the changed content from FIG. 5GP to FIG. 5GQ). For example, an affordance that corresponds to a maps application includes navigation information (such as next turn information) that updates in real time, or an affordance that corresponds to a media player includes media playback information that updates in real time. In some embodiments, the wake screen user interface 504 includes an intelligently selected app icon, e.g., a hand-off application. In some embodiments, the first affordance is displayed in addition to one or more additional objects on the wake screen (e.g., in addition to time indicator, notification affordances, and/or device control affordances). In some embodiments, the content from the active application displayed in the object (e.g., the pill object) on the home screen user interface is a miniaturized version of the content displayed in the first affordance on the wake screen user interface. For example, in comparison with content displayed in the first affordance on the wake screen, a miniaturized version of the content includes a reduced amount of text, text with reduced size, no text, a reduced number of icons, icons with reduced size, and/or no icons. In some embodiments, content displayed in the first affordance on the wake screen includes navigation instruction text and a navigation instruction icon having a first size, and the miniaturized version of the content includes no navigation instruction text and a navigation instruction icon having a second size that is smaller than the first size.

Updating the content displayed in the affordance displayed in the wake screen user interface in accordance with a changed state of an active application provides information to a user from an active application without displaying the full application user interface. This makes the user-device

interface more efficient by allowing a user to receive information from the application without providing input to navigate from the wake screen user interface to the application user interface.

In some embodiments, the wake screen user interface 504 includes (920) a first control (e.g., flashlight control 5190 and/or camera control 5192) of the one or more device controls of the control panel user interface 5138 (e.g., as shown in FIG. 5ED and 5EW). In some embodiments, the first control is, e.g., a flashlight control 5190 that corresponds to the flashlight control 5190 of the control panel user interface 5138. When operated, the flashlight control operates a device flashlight. In some embodiments, the affordance is, a camera control 5192 or another pre-selected (e.g., user-selected) control. In some embodiments, the wake screen user interface 504 includes one or more regions (e.g., lower left and lower right corners) that display affordances for pre-selected apps (e.g., a flashlight control icon 5190 and/or a camera application control icon 5192). In some embodiments, the wake screen user interface 504 includes at least one control affordance that does not correspond to a device control of the control panel user interface.

Providing controls from the control panel user interface on the wake screen user interface allows the user to access the same control functions from multiple locations, and thereby making the user-device interface more efficient (e.g., by reducing the number of steps needed to navigate to the control).

In some embodiments, the first control requires (922) a first type of input to activate a first function while displayed on the wake screen user interface and the first control requires a second type of input to activate the first function while displayed on the control panel user interface. In some embodiments, the first control requires different inputs for activating the same function (e.g., a press input is required to toggle the flashlight control 5190 on the wake screen user interface 504, as described with regard to FIGS. 5ED-5EJ, while a tap input is required to toggle the flashlight control 5190 in the control panel user interface 5138, as described with regard to FIGS. 5ES-5EW). In some embodiments, a plurality of pre-selected affordances are displayed on the wake screen. In some embodiments, the pre-selected affordances on the wake screen are user-customizable.

Requiring a different input to activate a function from the wake screen than the input that is required to activate the same function from the control center prevents accidental operation of the function (e.g., operation of the flashlight) when the phone wakes at a time that the user does not intend to operate the phone. This saves battery life (e.g., by not using battery to operate the flashlight when the flashlight is not needed).

In some embodiments, the first control (e.g., camera control 5192) is also displayed on the home screen user interface 522 (924), and a press input directed to the first control while displayed on the home screen user interface causes display of a plurality of selectable options (e.g., as shown in menu 5220), and a press input directed to the first control while displayed on the wake screen user interface does not cause display of the plurality of selectable options.

Displaying a plurality of selectable options in response to press input at control displayed on the home screen user interface and not displaying the plurality of selectable options when a press input is received at the same control displayed on the wake screen user interface prevents accidental access to functions among the plurality of selectable options (e.g., taking a photo) when the phone wakes at a time that the user does not intend to operate the phone. This saves



battery life (e.g., by not using battery to operate the camera when the camera is not needed).

In some embodiments, the wake screen has a plurality of luminosity display modes (e.g., bright mode, as shown in FIG. 5GV, and dark mode, as shown in FIG. 5GW) that are applied to one or more objects (e.g., notifications 5160, 5188, 5234, and other platters and/or banners, such as navigation banner 5160) displayed on the wake screen user interface 504. In some embodiments, the device determines a luminosity of the background (e.g., by performing image analysis on a background image to determine a luminosity value. The background image of the wake screen is, e.g., a default background image or a user-selected background image). The luminosity display mode switches based on the luminosity of the background. For example, a color of at least a portion of an area of one or more objects (e.g., a border around the object, a background of the object, text of the object, and/or an image displayed in the object) is changed when a luminosity mode changes (e.g., as described with regard to FIGS. 5GV-5GW). The change in color causes the object to have a greater degree of contrast with the background image to increase the visibility of the object relative to the background image.

In some embodiments, while displaying the wake screen user interface, the device displays (926) a first object (e.g., a time-date indicator 582) at a first position on the display 112 (e.g., the center of the first object is aligned with the horizontal symmetric center line of the display 112). In accordance with the determination that the first swipe gesture is in the first direction (e.g., as shown in FIGS. 5EK-5EL, the device displays the first object on the first user interface at a second position (e.g., as shown in FIG. 5EM) that is shifted in the first direction relative to the first position on the display). When the first swipe is a right swipe, as shown in FIGS. 5EK-5EL, the time indicator 582 is displayed on the right side of the mini-application-object user interface 5140 (e.g., in FIG. 5EM) to provide a visual indication of the input needed (a swipe to the left) to return to the wake screen. In accordance with the determination that the first swipe gesture is in the second direction (e.g., as shown at FIGS. 5EQ-5ER), the device displays the at least one object is at a third position (e.g., as shown in FIG. 5ES) that is shifted in the second direction relative to the first position on the display (e.g., when the first swipe is a left swipe, the time indicator 582 is displayed on the left side of the control panel user interface 5138 to provide a visual indication of the input needed (a swipe to the right) to return to the wake screen).

Shifting a position of a first object (e.g., a time-date indicator) in response to swipe gesture input provides an indication of a location of a current user interface relative to the wake screen user interface. Providing an indication of a location of a current user interface relative to the wake screen user interface reduces the number of inputs needed to return to the wake screen user interface by reducing the need for a user (e.g., a user that is new to the interface arrangement) to experimentally swipe in order to recall the location of a desired user interface relative to a current user interface.

It should be understood that the particular order in which the operations in FIGS. 9A-9C have been described is merely an example and is not intended to indicate that the described order is the only order in which the operations could be performed. One of ordinary skill in the art would recognize various ways to reorder the operations described herein. Additionally, it should be noted that details of other processes described herein with respect to other methods described herein (e.g., methods 600, 700, and 800) are also

applicable in an analogous manner to method 900 described above with respect to FIGS. 9A-9C. For example, the contacts, gestures, user interface objects, intensity thresholds, focus selectors, and animations described above with reference to method xxx optionally have one or more of the characteristics of the contacts, gestures, user interface objects, intensity thresholds, focus selectors, and animations described herein with reference to other methods described herein (e.g., methods 600, 700, and 800). For brevity, these details are not repeated here.

The operations described above with reference to FIGS. 9A-9C are, optionally, implemented by components depicted in FIGS. 1A-1B. For example, detection operation 902, transitioning operation 904, and displaying operation 908 are, optionally, implemented by event sorter 170, event recognizer 180, and event handler 190. Event monitor 171 in event sorter 170 detects a contact on touch-sensitive display 112, and event dispatcher module 174 delivers the event information to application 136-1. A respective event recognizer 180 of application 136-1 compares the event information to respective event definitions 186, and determines whether a first contact at a first location on the touch-sensitive surface (or whether rotation of the device) corresponds to a predefined event or sub-event, such as selection of an object on a user interface, or rotation of the device from one orientation to another. When a respective predefined event or sub-event is detected, event recognizer 180 activates an event handler 190 associated with the detection of the event or sub-event. Event handler 190 optionally uses or calls data updater 176 or object updater 177 to update the application internal state 192. In some embodiments, event handler 190 accesses a respective GUI updater 178 to update what is displayed by the application. Similarly, it would be clear to a person having ordinary skill in the art how other processes can be implemented based on the components depicted in FIGS. 1A-1B.

The foregoing description, for purpose of explanation, has been described with reference to specific embodiments. However, the illustrative discussions above are not intended to be exhaustive or to limit the invention to the precise forms disclosed. Many modifications and variations are possible in view of the above teachings. The embodiments were chosen and described in order to best explain the principles of the invention and its practical applications, to thereby enable others skilled in the art to best use the invention and various described embodiments with various modifications as are suited to the particular use contemplated.

What is claimed is:

1. A method, comprising:  
at computer system that is in communication with a display generation component and one or more input devices:  
while the computer system is in a power saving state, detecting an input that meets display-waking criteria;  
in response to detecting the input that meets the display-waking criteria, displaying, via the display generation component, a wake screen user interface;  
while displaying the wake screen user interface, detecting a first input that is directed to a portion of the wake screen user interface and includes first movement; and  
in response to detecting the first input that is directed to the portion of the wake screen user interface:  
in accordance with a determination that the first input meets first criteria, wherein the first criteria require the first movement to be in a first direction in order for the first criteria to be met:

US 11,106,352 B2

87

displaying of a home screen user interface that is different from the wake screen user interface, wherein the home screen user interface includes a plurality of application icons corresponding to different applications, and wherein a respective application icon of the plurality of application icons, when selected, causes display of an application corresponding to the respective application icon; and

in accordance with a determination that the first input meets second criteria different from the first criteria, wherein the second criteria require the first movement to be in a second direction that is different from the first direction in order for the second criteria to be met:

displaying a widget screen user interface that is different from the wake screen user interface and the home screen user interface, wherein the widget screen user interface includes a plurality of user interface objects corresponding to different applications, wherein a respective user interface object of the plurality of user interface objects contains application content from an application corresponding to the respective user interface object, and when selected, causes display of an application corresponding to the respective user interface object.

2. The method of claim 1, wherein the wake screen user interface is a user interface that has a first state that corresponds to an authenticated state of the computer system and a second state that corresponds to an unauthenticated state of the computer system.

3. The method of claim 1, including:

while displaying the widget screen user interface, detecting a second input that is directed to a portion of the widget screen user interface and includes second movement; and

in response to detecting the second input that is directed to the portion of the widget screen user interface:

in accordance with a determination that the second input meets third criteria, wherein the third criteria require the second movement to be in the first direction in order for the second criteria to be met, displaying the home screen user interface.

4. The method of claim 3, including:

while the home screen user interface is displayed in response to detection of the second input, detecting a third input that is directed to a portion of the home screen user interface and includes third movement; and in response to detecting the third input that is directed to the portion of the home screen user interface: in accordance with a determination that the third input meets fourth criteria, wherein the fourth criteria require the third movement to be in a third direction that is different from the first direction and the second direction in order for the fourth criteria to be met, redisplaying the widget screen user interface.

5. The method of claim 3, including:

while the home screen user interface is displayed in response to detection of the second input, detecting a fourth input that is directed to a portion of the home screen user interface and includes fourth movement; and

in response to detecting the fourth input that is directed to the portion of the home screen user interface:

in accordance with a determination that the fourth input meets fifth criteria, wherein the fifth criteria require

88

the fourth movement to be in a third direction that is different from the first direction and the second direction in order for the fifth criteria to be met, redisplaying the wake screen user interface.

6. The method of claim 1, including:

while the home screen user interface is displayed in response to detection of the first input, detecting a fifth input that is directed to a portion of the home screen user interface and includes fifth movement; and

in response to detecting the fifth input that is directed to the portion of the home screen user interface:

in accordance with a determination that the fifth input meets sixth criteria, wherein the sixth criteria require the fifth movement to be in a fourth direction that is different from the first direction and the second direction in order for the sixth criteria to be met, redisplaying the wake screen user interface.

7. The method of claim 1, including:

in response to detecting the first input that is directed to the portion of the wake screen user interface:

in accordance with a determination that the first input meets seventh criteria, wherein the seventh criteria require the first movement to be in a fifth direction that is different from the first direction and the second direction in order for the seventh criteria to be met:

displaying of a control panel user interface that is different from the wake screen user interface and the widget screen user interface, wherein the control panel user interface includes a plurality of controls for controlling one or more device functions of the computer system.

8. The method of claim 7, including:

while the control panel user interface is displayed in response to detection of the first input, detecting a sixth input that is directed to a portion of the control panel user interface and includes sixth movement; and

in response to detecting the sixth input that is directed to the portion of the control panel user interface:

in accordance with a determination that the sixth input meets eighth criteria, wherein the eighth criteria require the sixth movement to be in a sixth direction (e.g., rightward swipe) that is opposite the fifth direction in order for the eighth criteria to be met, redisplaying the wake screen user interface.

9. A computer system, comprising:

one or more processors that are in communication with a display generation component and one or more input devices; and

memory storing instructions, the instructions, when executed by the one or more processors, cause the processors to perform operations comprising:

while the computer system is in a power saving state, detecting an input that meets display-waking criteria; in response to detecting the input that meets the display-waking criteria, displaying, via the display generation component, a wake screen user interface;

while displaying the wake screen user interface, detecting a first input that is directed to a portion of the wake screen user interface and includes first movement; and

in response to detecting the first input that is directed to the portion of the wake screen user interface:

in accordance with a determination that the first input meets first criteria, wherein the first criteria require the first movement to be in a first direction in order for the first criteria to be met:



US 11,106,352 B2

89

displaying of a home screen user interface that is different from the wake screen user interface, wherein the home screen user interface includes a plurality of application icons corresponding to different applications, and wherein a respective application icon of the plurality of application icons, when selected, causes display of an application corresponding to the respective application icon; and

in accordance with a determination that the first input meets second criteria different from the first criteria, wherein the second criteria require the first movement to be in a second direction that is different from the first direction in order for the second criteria to be met:

displaying a widget screen user interface that is different from the wake screen user interface and the home screen user interface, wherein the widget screen user interface includes a plurality of user interface objects corresponding to different applications, wherein a respective user interface object of the plurality of user interface objects contains application content from an application corresponding to the respective user interface object, and when selected, causes display of an application corresponding to the respective user interface object.

10. The computer system of claim 9, wherein the wake screen user interface is a user interface that has a first state that corresponds to an authenticated state of the computer system and a second state that corresponds to an unauthenticated state of the computer system.

11. The computer system of claim 9, wherein the operations include:

while displaying the widget screen user interface, detecting a second input that is directed to a portion of the widget screen user interface and includes second movement; and

in response to detecting the second input that is directed to the portion of the widget screen user interface:

in accordance with a determination that the second input meets third criteria, wherein the third criteria require the second movement to be in the first direction in order for the second criteria to be met, displaying the home screen user interface.

12. The computer system of claim 11, wherein the operations include:

while the home screen user interface is displayed in response to detection of the second input, detecting a third input that is directed to a portion of the home screen user interface and includes third movement; and in response to detecting the third input that is directed to the portion of the home screen user interface:

in accordance with a determination that the third input meets fourth criteria, wherein the fourth criteria require the third movement to be in a third direction that is different from the first direction and the second direction in order for the fourth criteria to be met, redisplaying the widget screen user interface.

13. The computer system of claim 11, wherein the operations include:

while the home screen user interface is displayed in response to detection of the second input, detecting a fourth input that is directed to a portion of the home screen user interface and includes fourth movement; and

90

in response to detecting the fourth input that is directed to the portion of the home screen user interface:

in accordance with a determination that the fourth input meets fifth criteria, wherein the fifth criteria require the fourth movement to be in a third direction that is different from the first direction and the second direction in order for the fifth criteria to be met, redisplaying the wake screen user interface.

14. The computer system of claim 9, wherein the operations include:

while the home screen user interface is displayed in response to detection of the first input, detecting a fifth input that is directed to a portion of the home screen user interface and includes fifth movement; and

in response to detecting the fifth input that is directed to the portion of the home screen user interface:

in accordance with a determination that the fifth input meets sixth criteria, wherein the sixth criteria require the fifth movement to be in a fourth direction that is different from the first direction and the second direction in order for the sixth criteria to be met, redisplaying the wake screen user interface.

15. The computer system of claim 9, wherein the operations include:

in response to detecting the first input that is directed to the portion of the wake screen user interface:

in accordance with a determination that the first input meets seventh criteria, wherein the seventh criteria require the first movement to be in a fifth direction that is different from the first direction and the second direction in order for the seventh criteria to be met:

displaying of a control panel user interface that is different from the wake screen user interface and the widget screen user interface, wherein the control panel user interface includes a plurality of controls for controlling one or more device functions of the computer system.

16. The computer system of claim 15, wherein the operations include

while the control panel user interface is displayed in response to detection of the first input, detecting a sixth input that is directed to a portion of the control panel user interface and includes sixth movement; and

in response to detecting the sixth input that is directed to the portion of the control panel user interface:

in accordance with a determination that the sixth input meets eighth criteria, wherein the eighth criteria require the sixth movement to be in a sixth direction (e.g., rightward swipe) that is opposite the fifth direction in order for the eighth criteria to be met, redisplaying the wake screen user interface.

17. A computer-readable storage medium comprising instructions, the instructions, when executed by one or more processors of a computer system that is in communication with a display generation component and one or more input devices, cause the processors to perform operations comprising:

while the computer system is in a power saving state, detecting an input that meets display-waking criteria; in response to detecting the input that meets the display-waking criteria, displaying, via the display generation component, a wake screen user interface;

while displaying the wake screen user interface, detecting a first input that is directed to a portion of the wake screen user interface and includes first movement; and

US 11,106,352 B2

91

in response to detecting the first input that is directed to the portion of the wake screen user interface:

in accordance with a determination that the first input meets first criteria, wherein the first criteria require the first movement to be in a first direction in order for the first criteria to be met:

displaying of a home screen user interface that is different from the wake screen user interface, wherein the home screen user interface includes a plurality of application icons corresponding to different applications, and wherein a respective application icon of the plurality of application icons, when selected, causes display of an application corresponding to the respective application icon; and

in accordance with a determination that the first input meets second criteria different from the first criteria, wherein the second criteria require the first movement to be in a second direction that is different from the first direction in order for the second criteria to be met:

displaying a widget screen user interface that is different from the wake screen user interface and the home screen user interface, wherein the widget screen user interface includes a plurality of user interface objects corresponding to different applications, wherein a respective user interface object of the plurality of user interface objects contains application content from an application corresponding to the respective user interface object, and when selected, causes display of an application corresponding to the respective user interface object.

18. The computer-readable storage medium of claim 17, wherein the wake screen user interface is a user interface that has a first state that corresponds to an authenticated state of the computer system and a second state that corresponds to an unauthenticated state of the computer system.

19. The computer-readable storage medium of claim 17, wherein the operations include:

while displaying the widget screen user interface, detecting a second input that is directed to a portion of the widget screen user interface and includes second movement; and

in response to detecting the second input that is directed to the portion of the widget screen user interface:

in accordance with a determination that the second input meets third criteria, wherein the third criteria require the second movement to be in the first direction in order for the second criteria to be met, displaying the home screen user interface.

20. The computer-readable storage medium of claim 19, wherein the operations include:

while the home screen user interface is displayed in response to detection of the second input, detecting a third input that is directed to a portion of the home screen user interface and includes third movement; and in response to detecting the third input that is directed to the portion of the home screen user interface:

in accordance with a determination that the third input meets fourth criteria, wherein the fourth criteria require the third movement to be in a third direction that is different from the first direction and the

92

second direction in order for the fourth criteria to be met, redisplaying the widget screen user interface.

21. The computer-readable storage medium of claim 19, wherein the operations include:

while the home screen user interface is displayed in response to detection of the second input, detecting a fourth input that is directed to a portion of the home screen user interface and includes fourth movement; and

in response to detecting the fourth input that is directed to the portion of the home screen user interface:

in accordance with a determination that the fourth input meets fifth criteria, wherein the fifth criteria require the fourth movement to be in a third direction that is different from the first direction and the second direction in order for the fifth criteria to be met, redisplaying the wake screen user interface.

22. The computer-readable storage medium of claim 17, wherein the operations include:

while the home screen user interface is displayed in response to detection of the first input, detecting a fifth input that is directed to a portion of the home screen user interface and includes fifth movement; and

in response to detecting the fifth input that is directed to the portion of the home screen user interface:

in accordance with a determination that the fifth input meets sixth criteria, wherein the sixth criteria require the fifth movement to be in a fourth direction that is different from the first direction and the second direction in order for the sixth criteria to be met, redisplaying the wake screen user interface.

23. The computer-readable storage medium of claim 17, wherein the operations include:

in response to detecting the first input that is directed to the portion of the wake screen user interface:

in accordance with a determination that the first input meets seventh criteria, wherein the seventh criteria require the first movement to be in a fifth direction that is different from the first direction and the second direction in order for the seventh criteria to be met:

displaying of a control panel user interface that is different from the wake screen user interface and the widget screen user interface, wherein the control panel user interface includes a plurality of controls for controlling one or more device functions of the computer system.

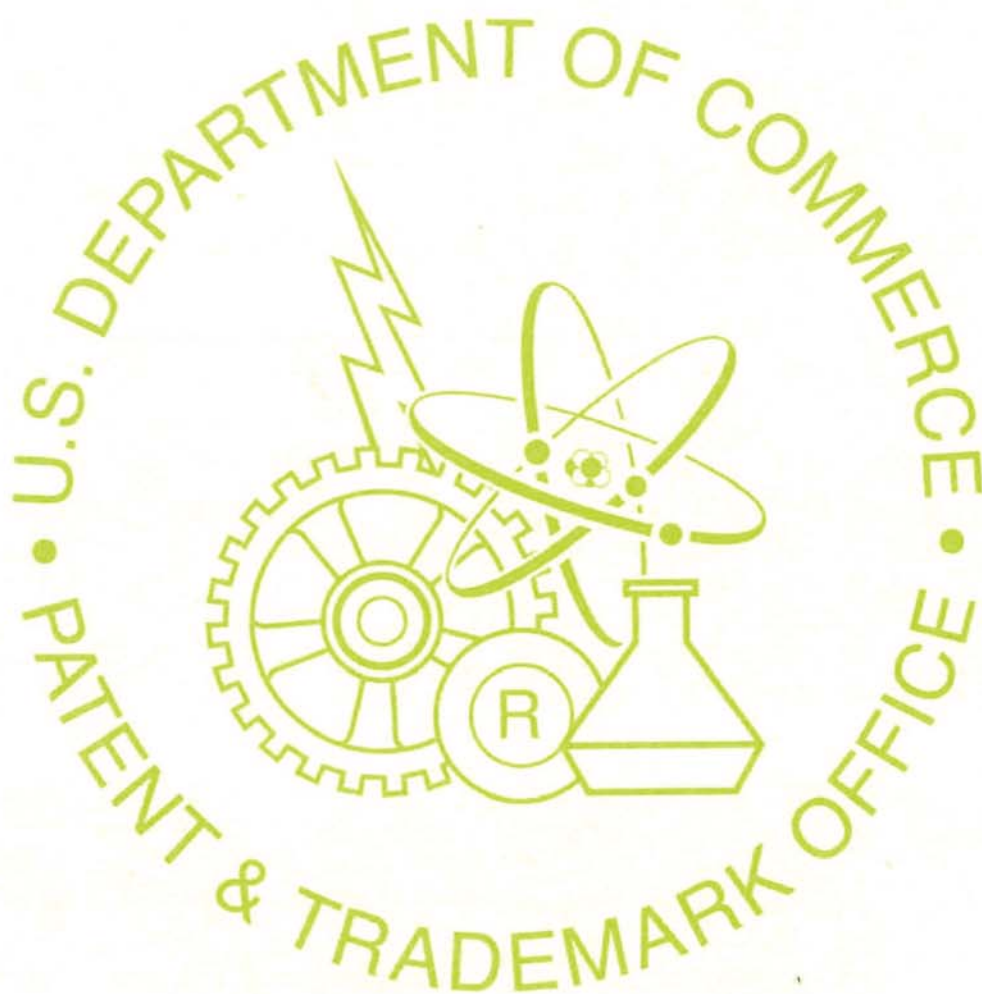
24. The computer-readable storage medium of claim 23, wherein the operations include

while the control panel user interface is displayed in response to detection of the first input, detecting a sixth input that is directed to a portion of the control panel user interface and includes sixth movement; and

in response to detecting the sixth input that is directed to the portion of the control panel user interface:

in accordance with a determination that the sixth input meets eighth criteria, wherein the eighth criteria require the sixth movement to be in a sixth direction (e.g., rightward swipe) that is opposite the fifth direction in order for the eighth criteria to be met, redisplaying the wake screen user interface.

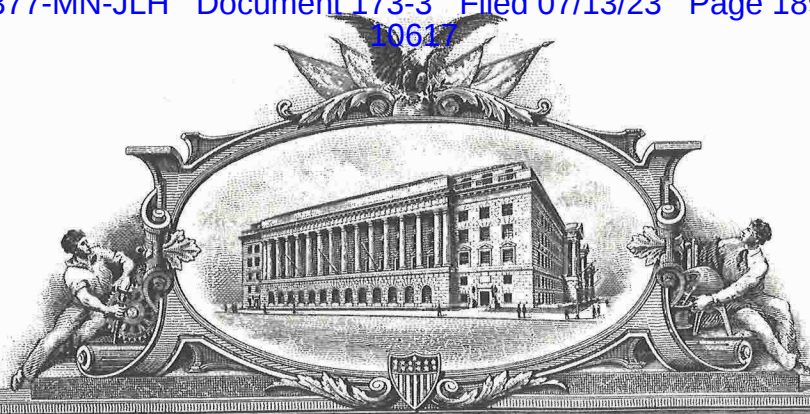
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# **EXHIBIT 10**



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# THE UNITED STATES OF AMERICA

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PATENT NUMBER: 11,474,483

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By Authority of the  
Under Secretary of Commerce for Intellectual Property  
and Director of the United States Patent and Trademark Office

Miguel Tarver  
Certifying Officer





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(12) **United States Patent**  
**Rothkopf et al.**

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(45) **Date of Patent:** **Oct. 18, 2022**

(54) **WEARABLE ELECTRONIC DEVICE**

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(71) Applicant: **Apple Inc.**, Cupertino, CA (US)

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(72) Inventors: **Fletcher R. Rothkopf**, Los Altos, CA (US); **Jonathan Ive**, San Francisco, CA (US); **Julian Hoenig**, San Francisco, CA (US); **Rico Zorkendorfer**, San Francisco, CA (US)

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(73) Assignee: **APPLE INC.**, Cupertino, CA (US)

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(57) **ABSTRACT**

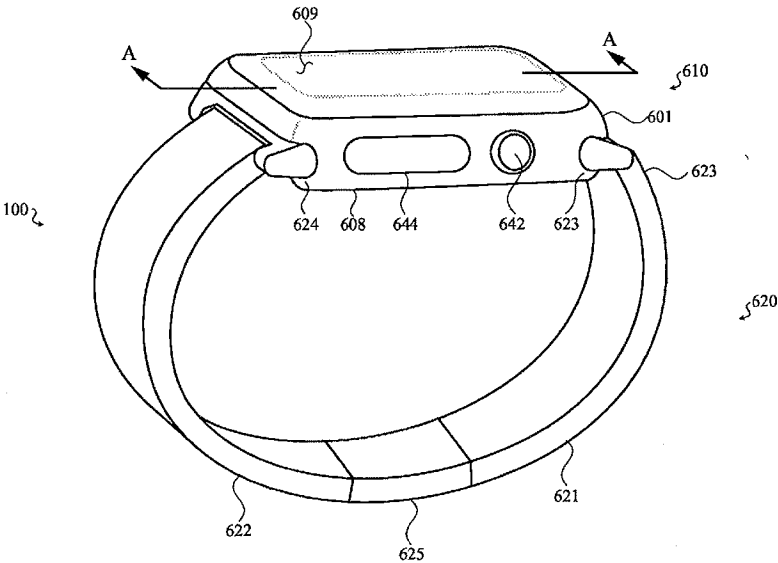
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A consumer product that is a portable and, in some cases, a wearable electronic device. The wearable electronic device may have functionalities including: keeping time; monitoring a user's physiological signals and providing health-related information based on those signals; communicating with other electronic devices or services; visually depicting data on a display; gather data form one or more sensors that may be used to initiate, control, or modify operations of the device; determine a location of a touch on a surface of the device and/or an amount of force exerted on the device, and use either or both as input.

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## US 11,474,483 B2

Page 2

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- 17/188,966, filed on Mar. 1, 2021, which is a continuation of application No. 16/826,130, filed on Mar. 20, 2020, now Pat. No. 10,942,491, said application No. 17/188,995 is a continuation of application No. 16/826,130, filed on Mar. 20, 2020, now Pat. No. 10,942,491, which is a continuation of application No. 15/261,917, filed on Sep. 10, 2016, now Pat. No. 10,627,783, and a continuation of application No. 15/261,912, filed on Sep. 10, 2016, now Pat. No. 10,620,591, and a continuation of application No. 15/261,914, filed on Sep. 10, 2016, now Pat. No. 10,613,485, and a continuation of application No. 14/842,617, filed on Sep. 1, 2015, now Pat. No. 10,599,101, said application No. 15/261,917 is a continuation of application No. 14/842,617, filed on Sep. 1, 2015, now Pat. No. 10,599,101, said application No. 15/261,914 is a continuation of application No. 14/842,617, filed on Sep. 1, 2015, now Pat. No. 10,599,101, said application No. 15/261,912 is a continuation of application No. 14/842,617, filed on Sep. 1, 2015, now Pat. No. 10,599,101.
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Page 4

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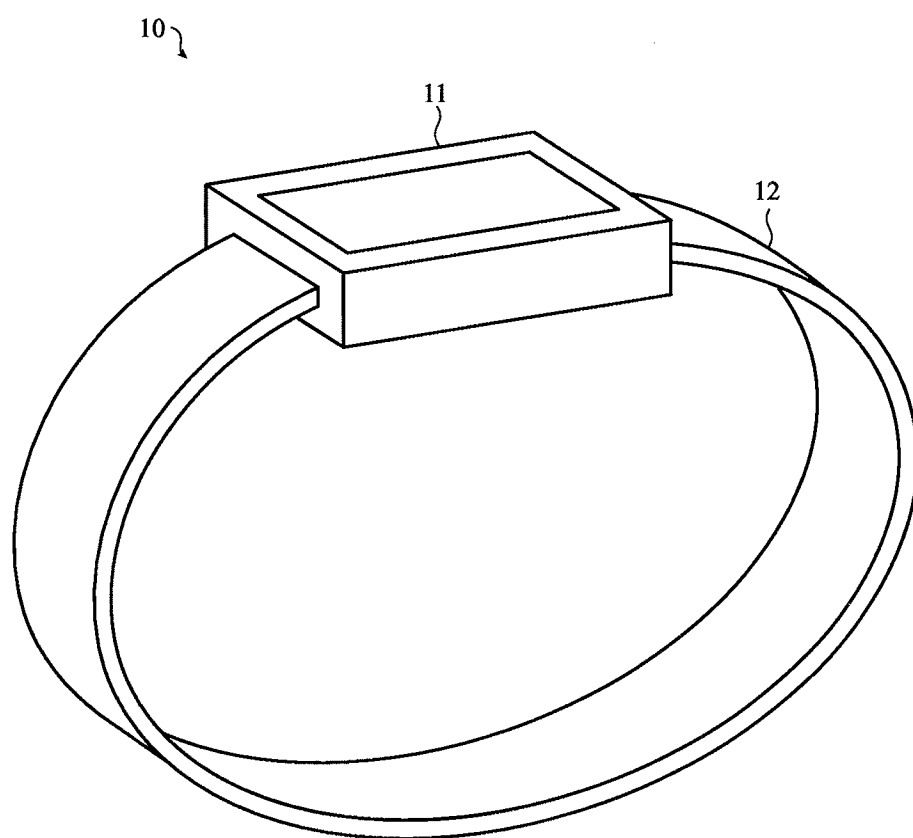


**U.S. Patent**

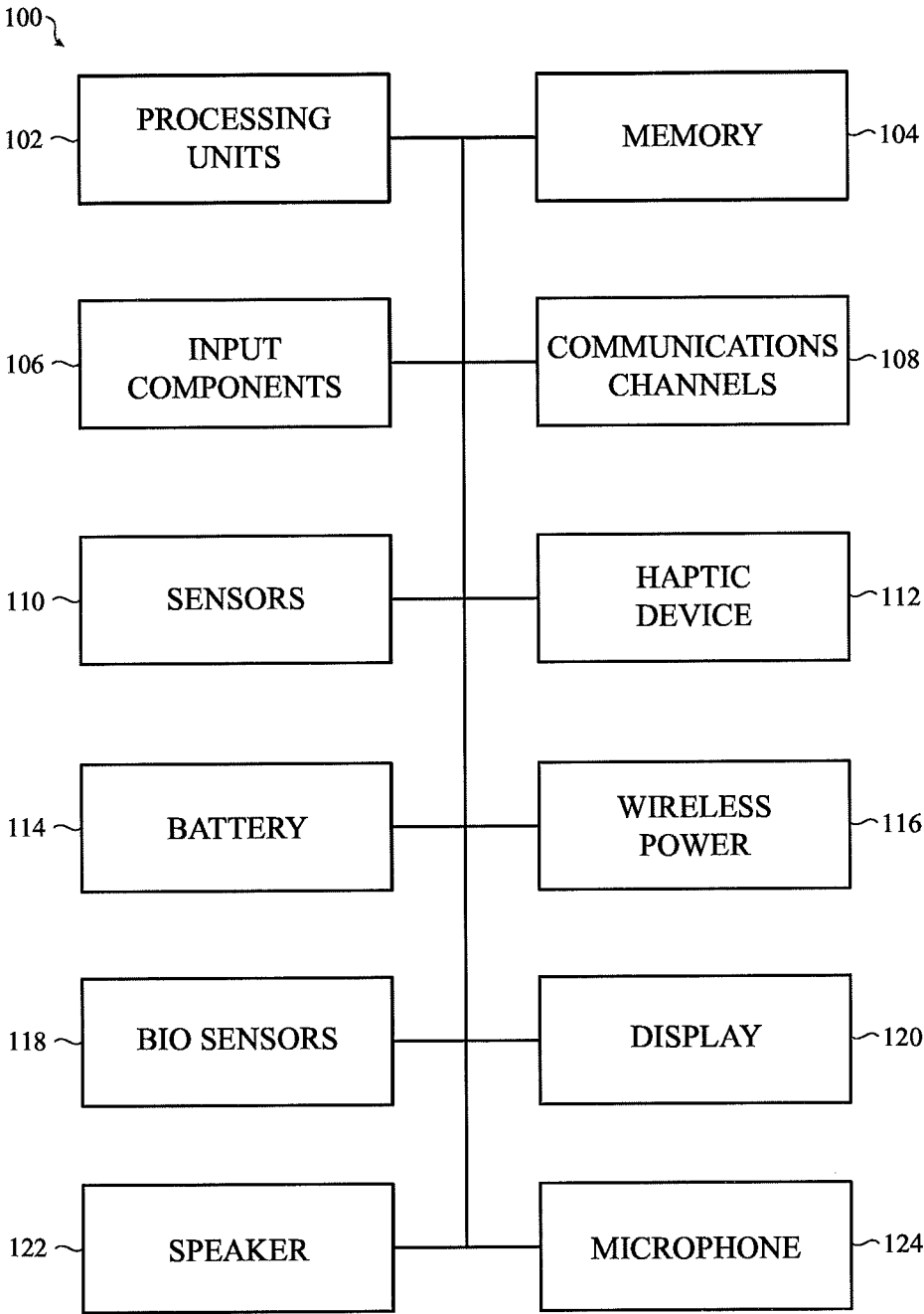
**Oct. 18, 2022**

**Sheet 1 of 26**

**US 11,474,483 B2**



**FIG. 1**



**FIG. 2**

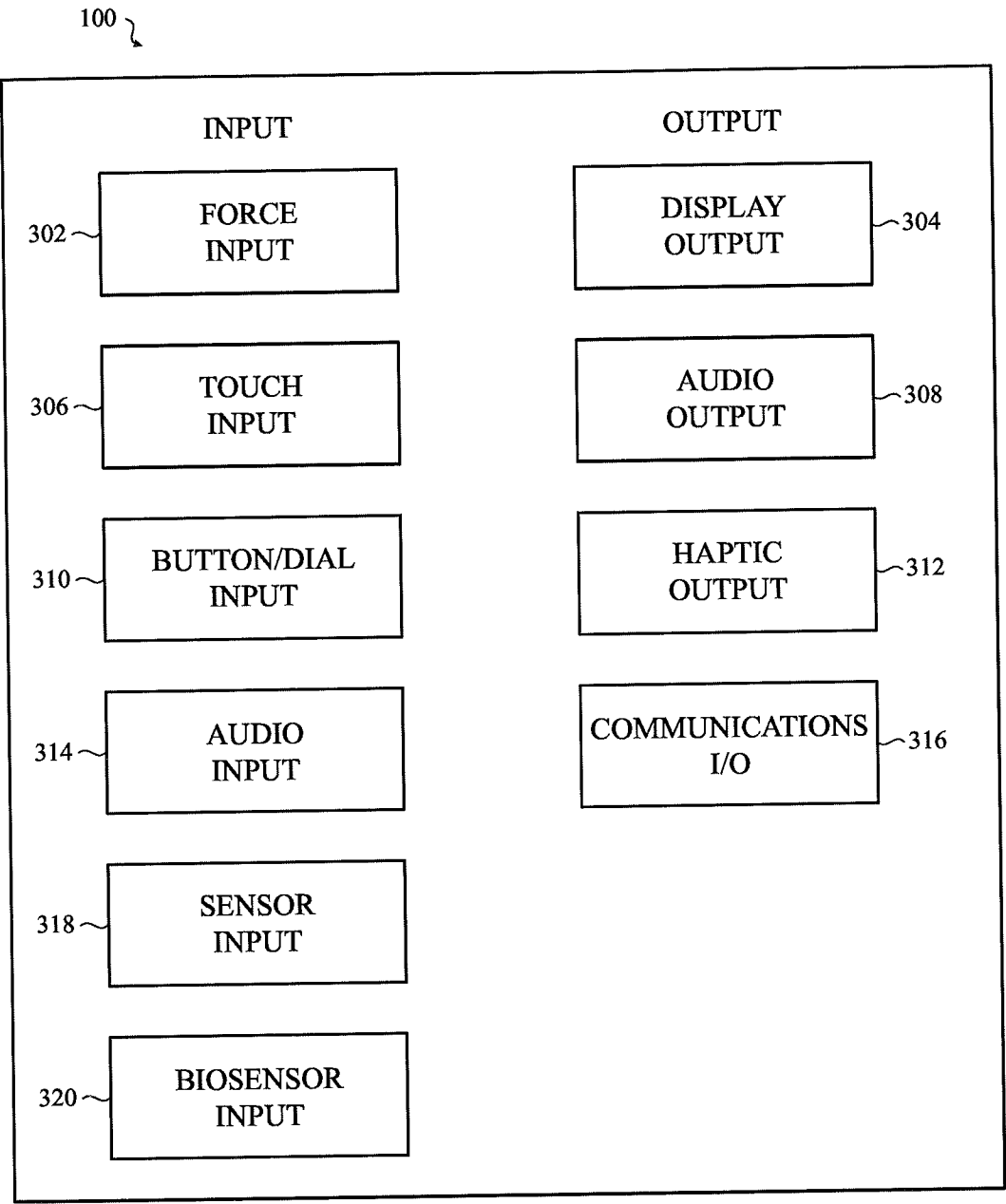


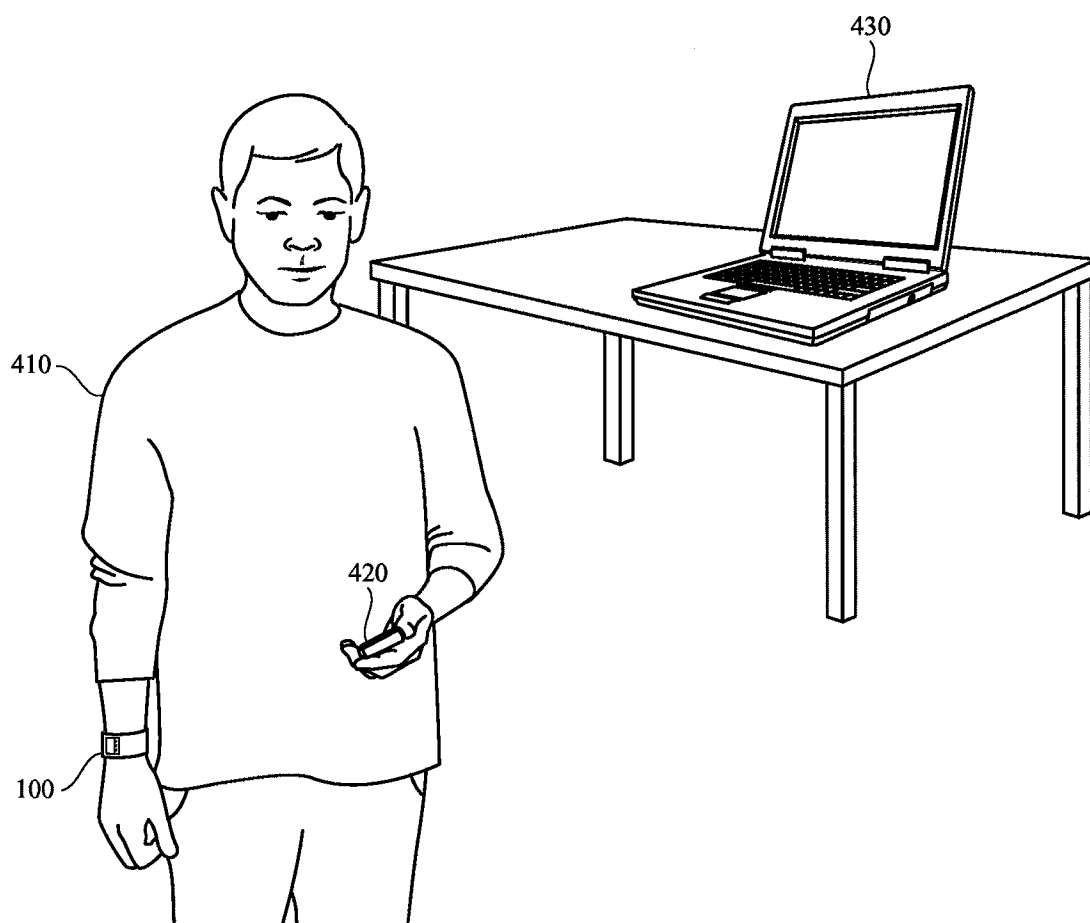
FIG. 3

**U.S. Patent**

**Oct. 18, 2022**

**Sheet 4 of 26**

**US 11,474,483 B2**



**FIG. 4**

U.S. Patent

Oct. 18, 2022

Sheet 5 of 26

US 11,474,483 B2

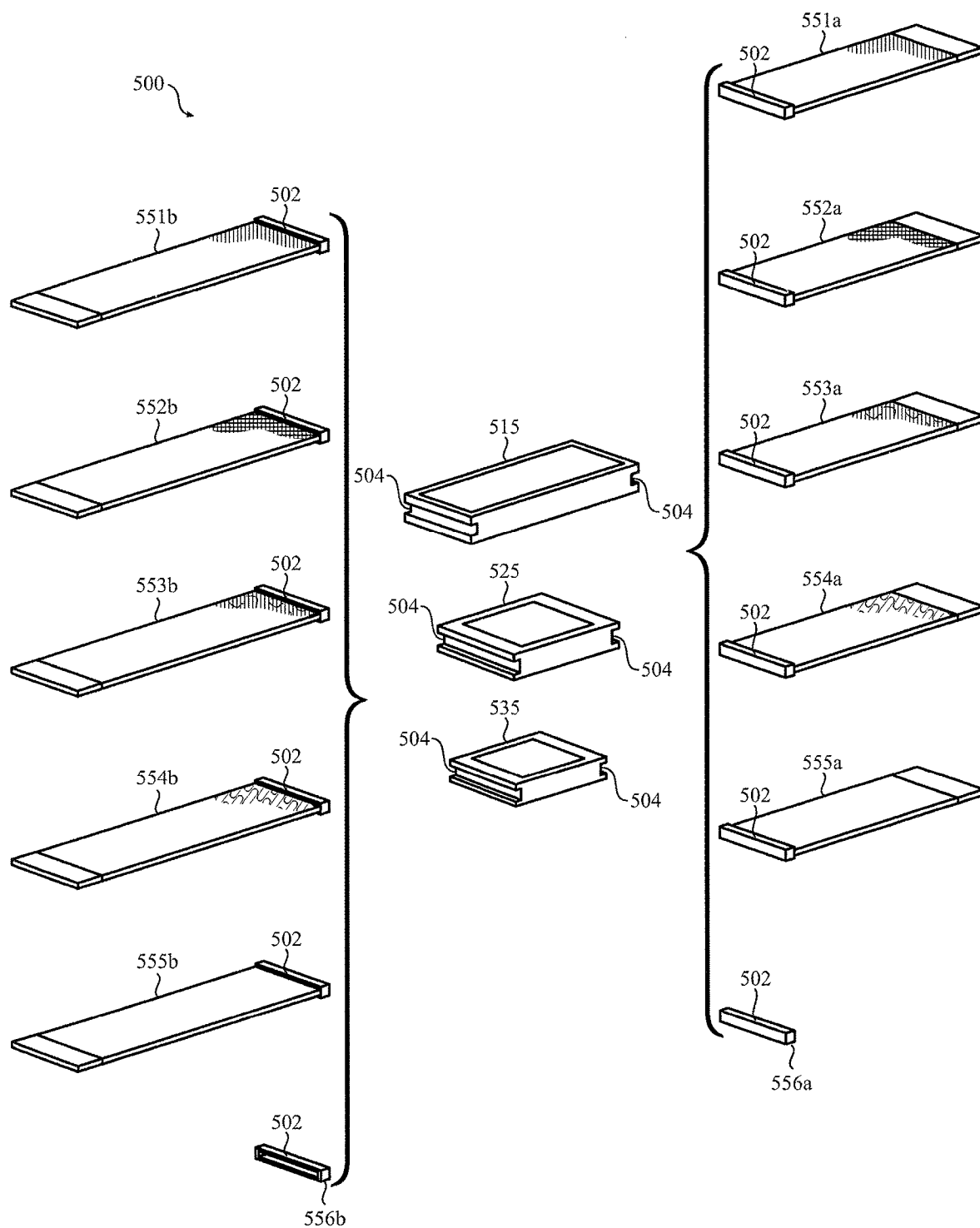


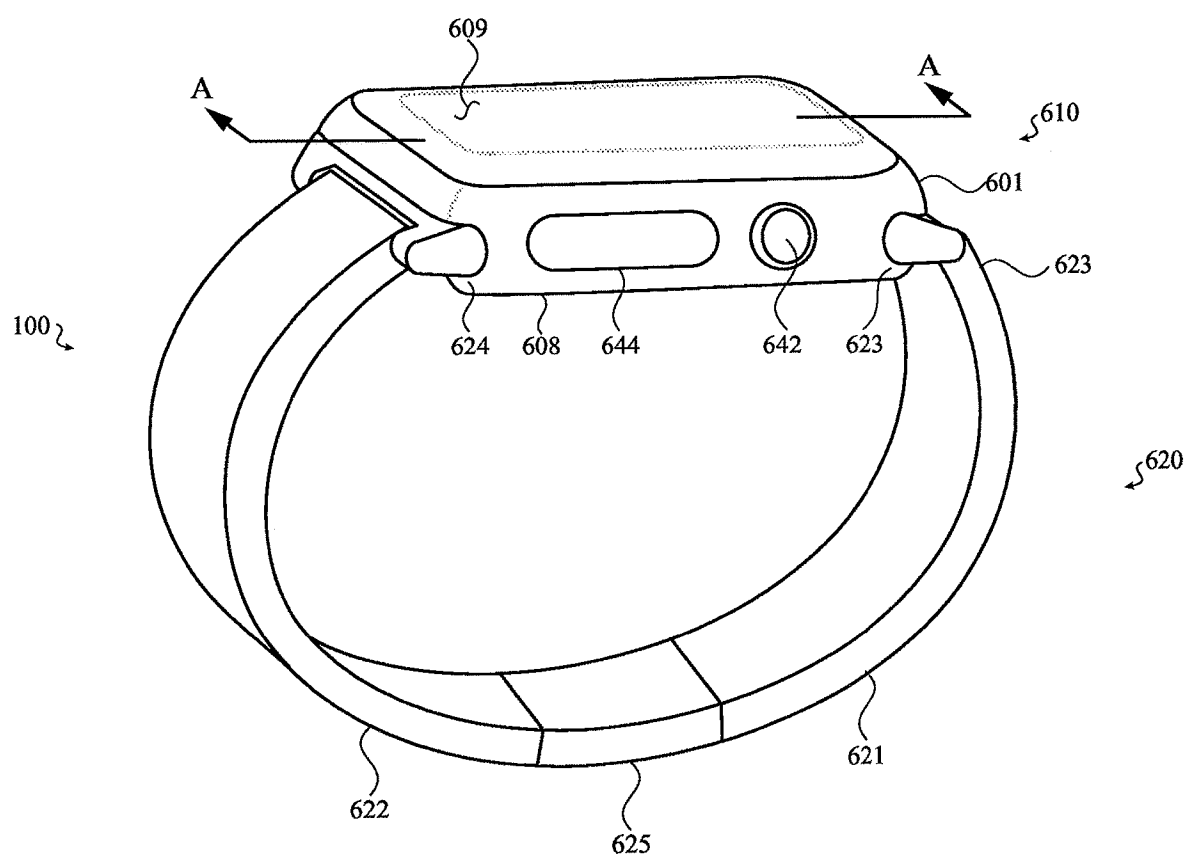
FIG. 5

U.S. Patent

Oct. 18, 2022

Sheet 6 of 26

US 11,474,483 B2



**FIG. 6**



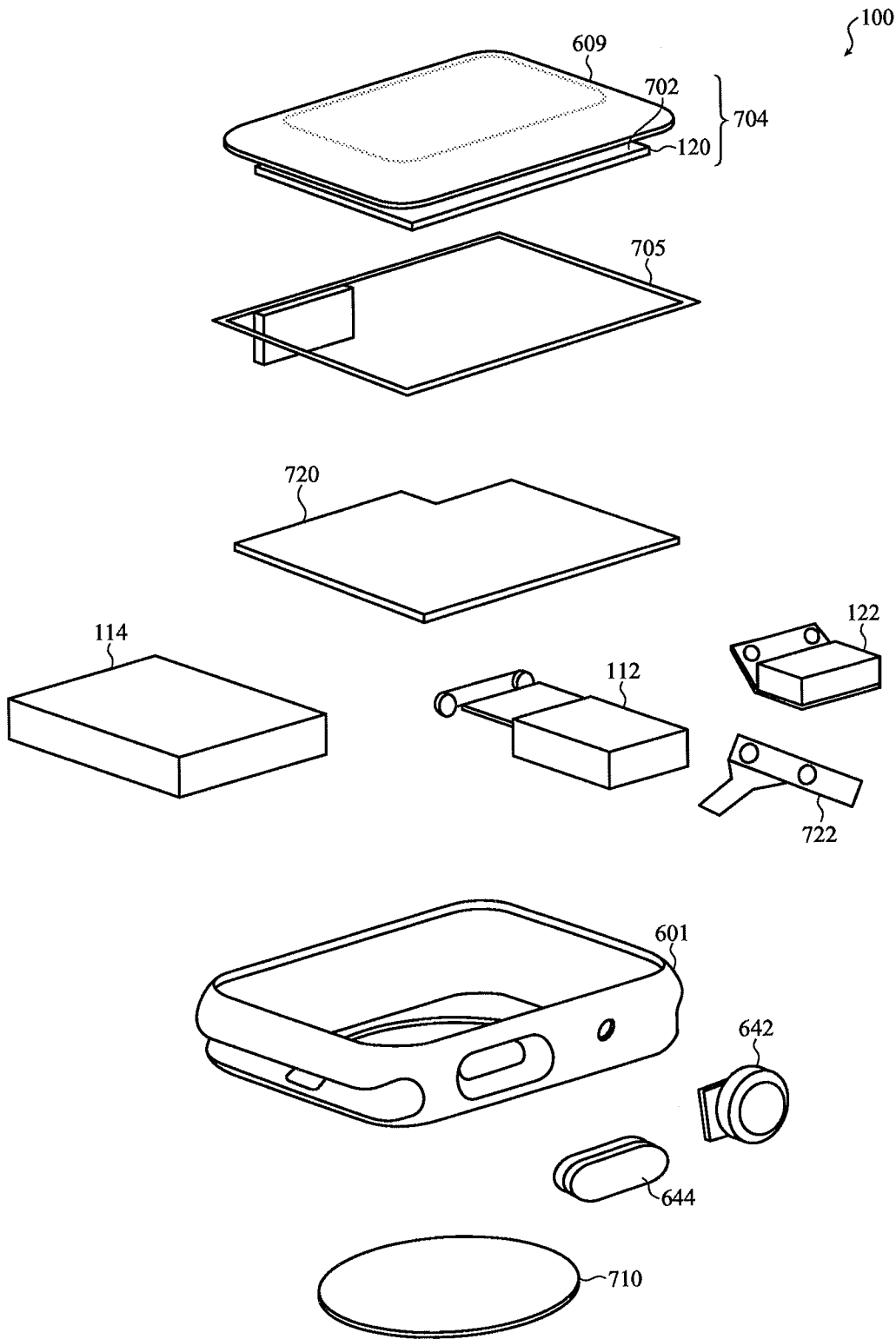


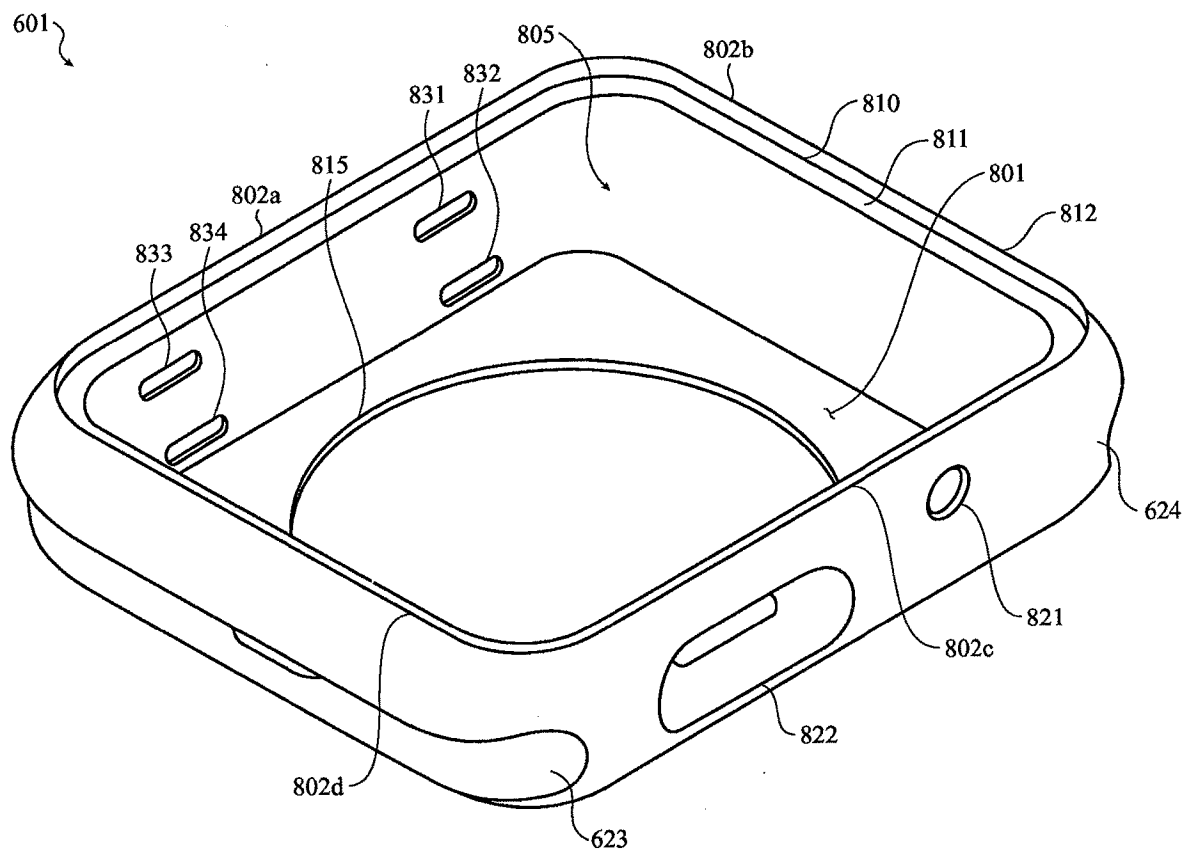
FIG. 7

## U.S. Patent

**Oct. 18, 2022**

Sheet 8 of 26

US 11,474,483 B2



U.S. Patent

Oct. 18, 2022

Sheet 9 of 26

US 11,474,483 B2

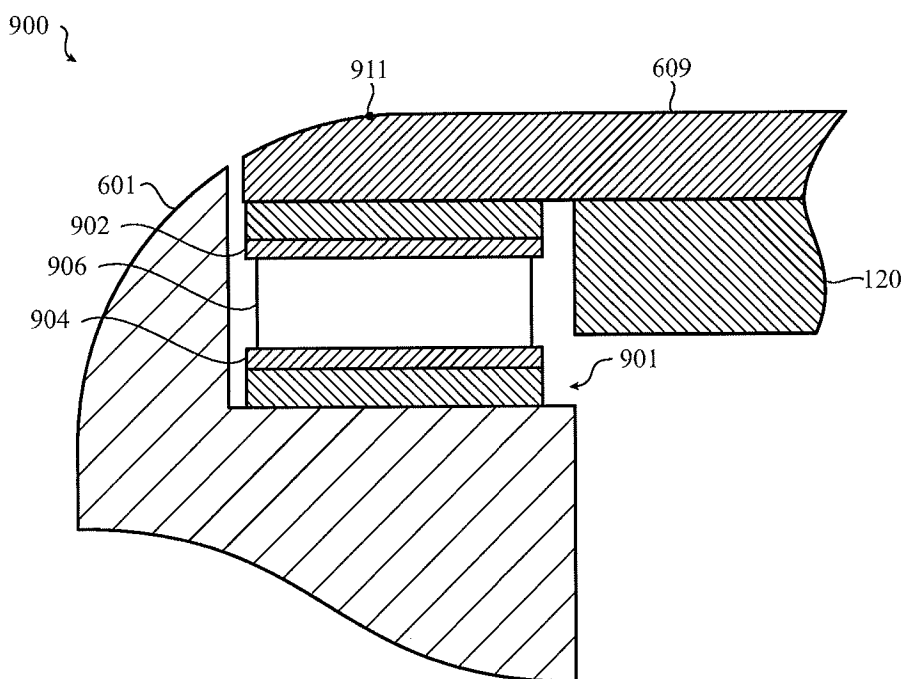


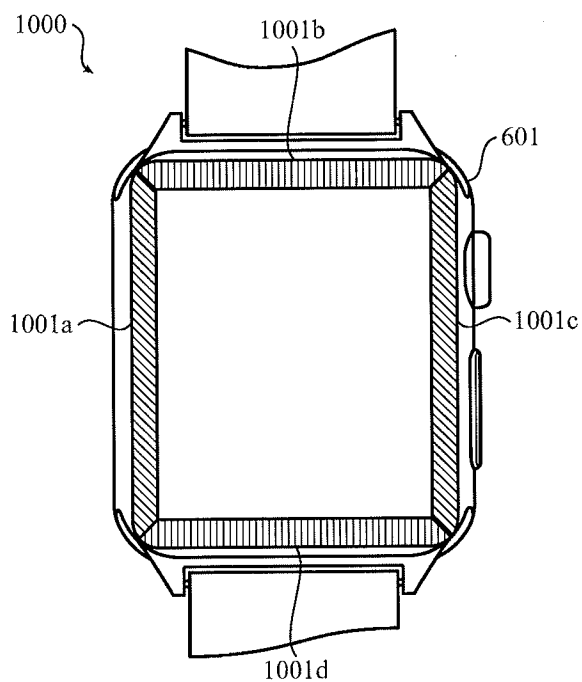
FIG. 9

U.S. Patent

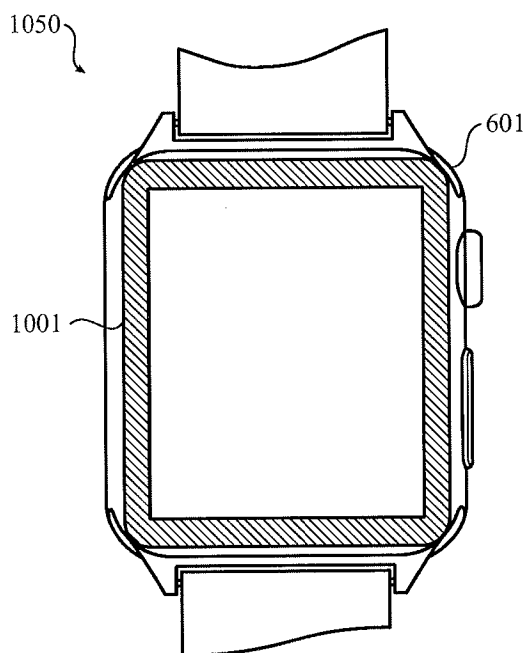
Oct. 18, 2022

Sheet 10 of 26

US 11,474,483 B2



**FIG. 10A**



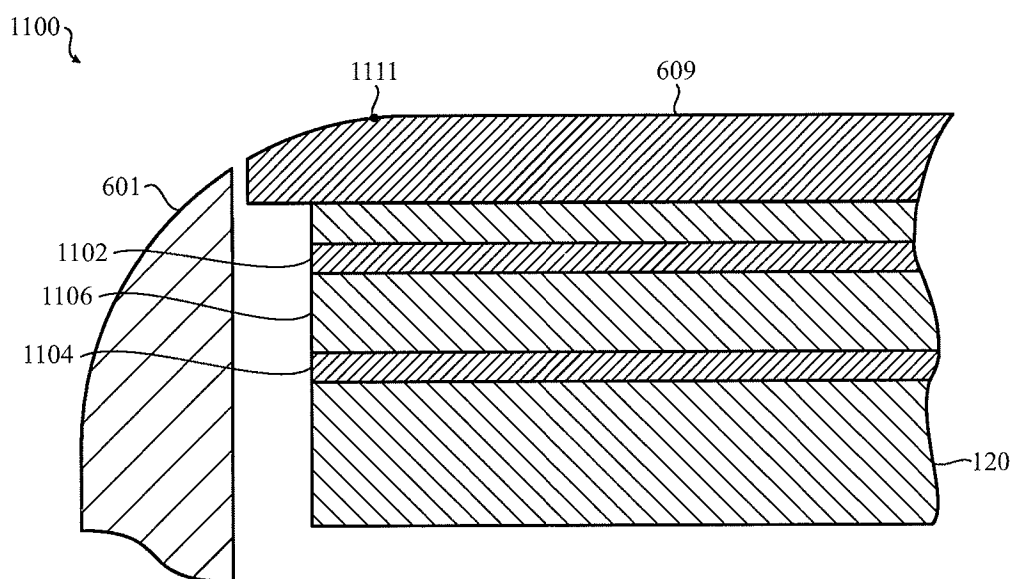
**FIG. 10B**

**U.S. Patent**

**Oct. 18, 2022**

**Sheet 11 of 26**

**US 11,474,483 B2**



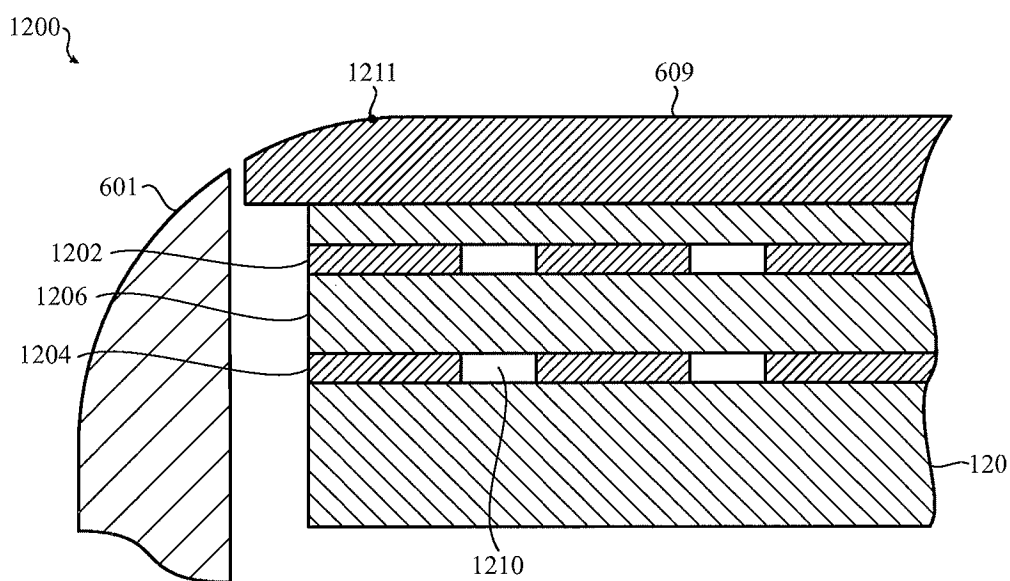
**FIG. 11**

U.S. Patent

Oct. 18, 2022

Sheet 12 of 26

US 11,474,483 B2



**FIG. 12**

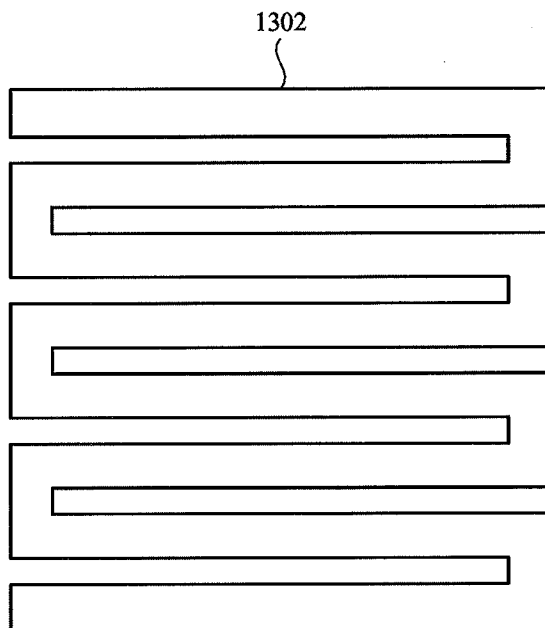


**U.S. Patent**

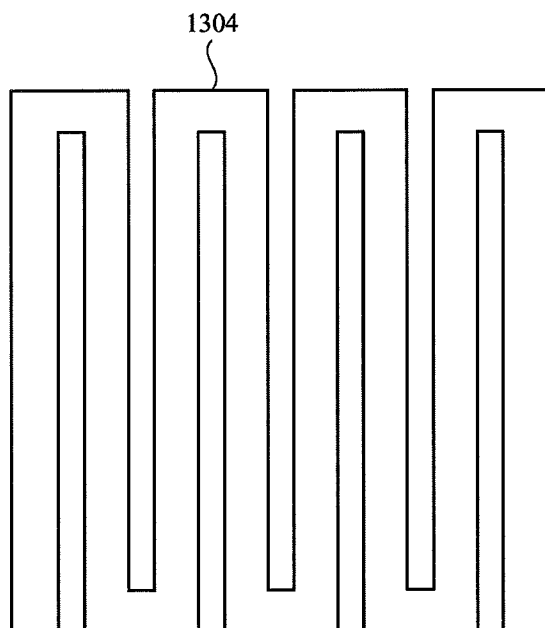
**Oct. 18, 2022**

**Sheet 13 of 26**

**US 11,474,483 B2**



***FIG. 13A***



***FIG. 13B***

U.S. Patent

Oct. 18, 2022

Sheet 14 of 26

US 11,474,483 B2

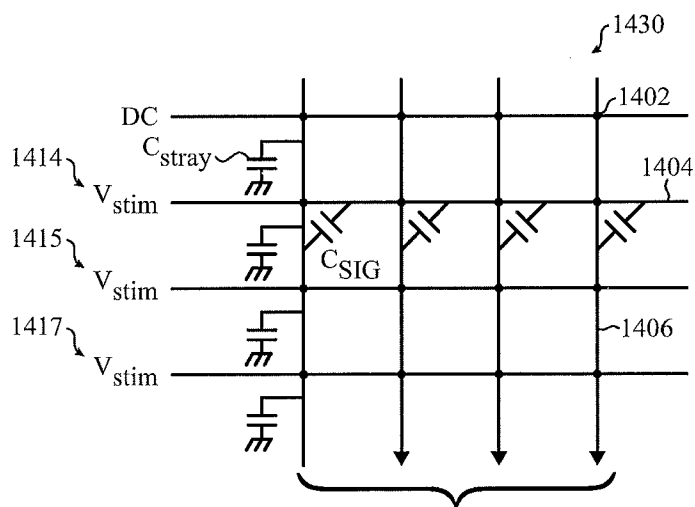


FIG. 14A

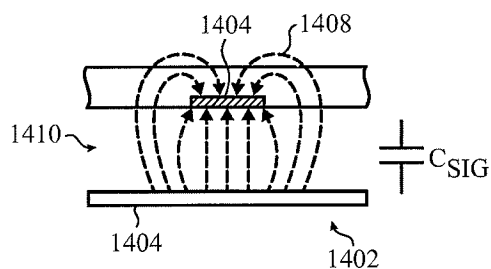


FIG. 14B

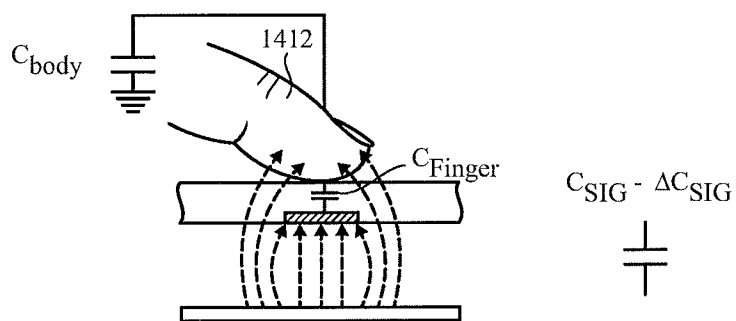


FIG. 14C

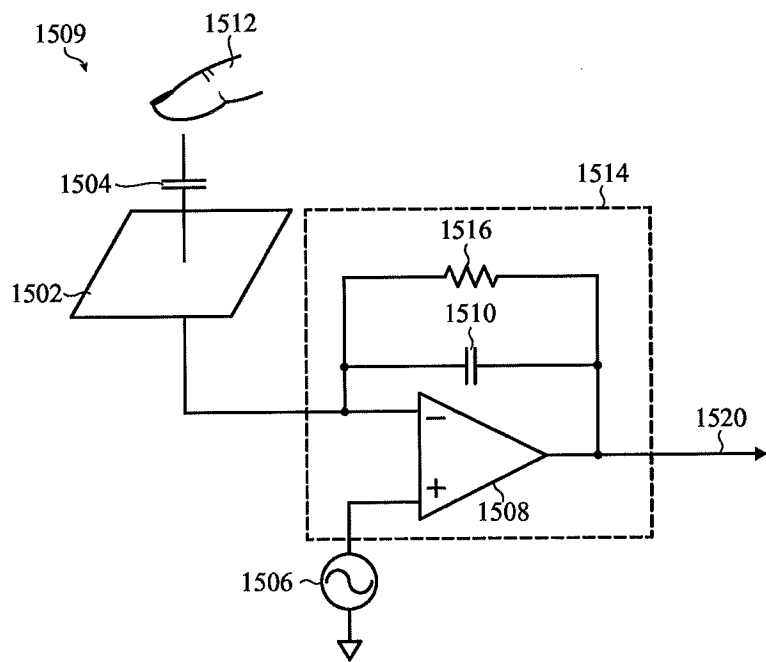


FIG. 15A

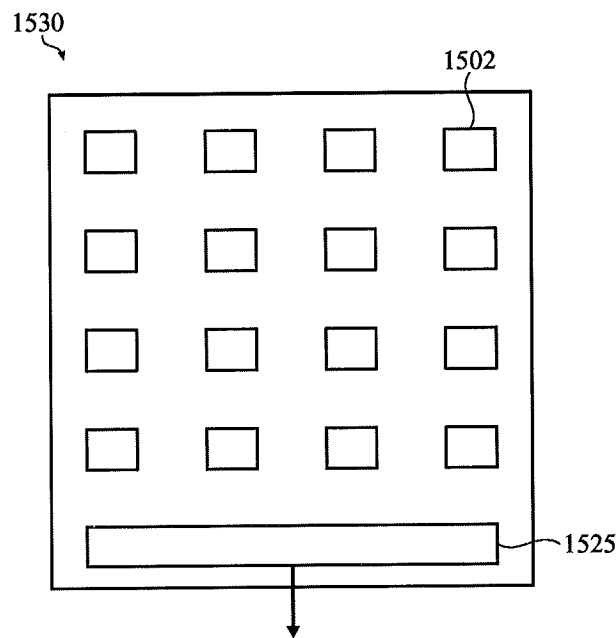


FIG. 15B

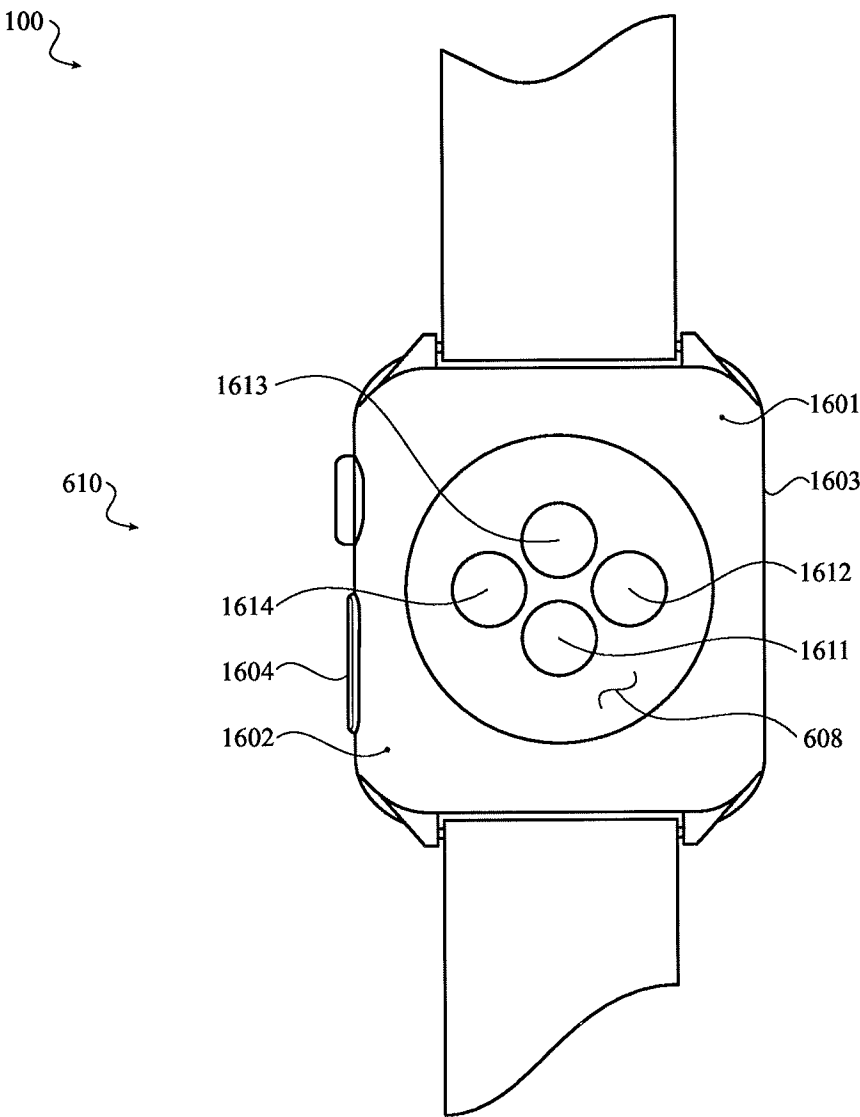


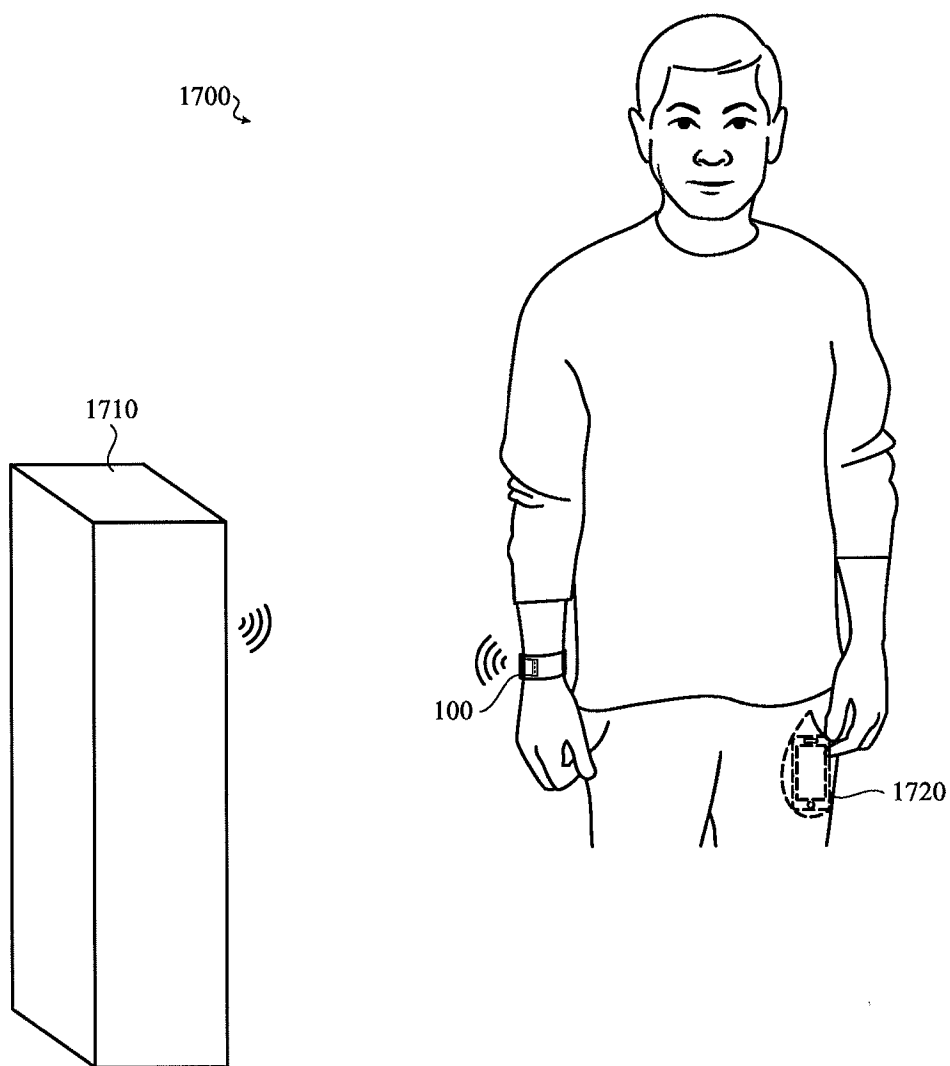
FIG. 16

**U.S. Patent**

**Oct. 18, 2022**

**Sheet 17 of 26**

**US 11,474,483 B2**



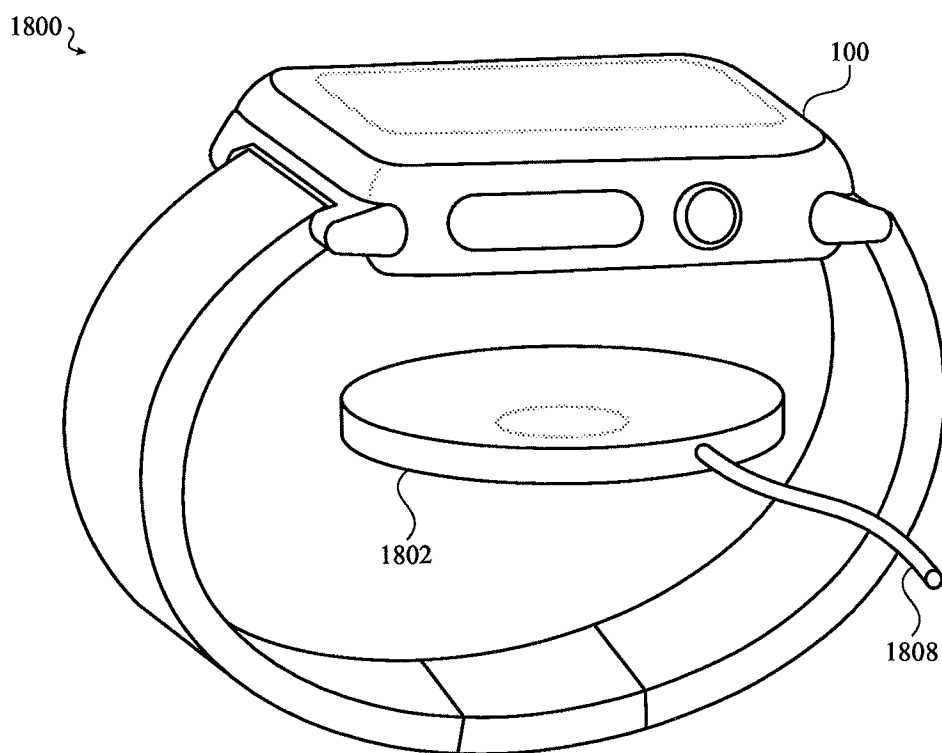
**FIG. 17**

U.S. Patent

Oct. 18, 2022

Sheet 18 of 26

US 11,474,483 B2



**FIG. 18**



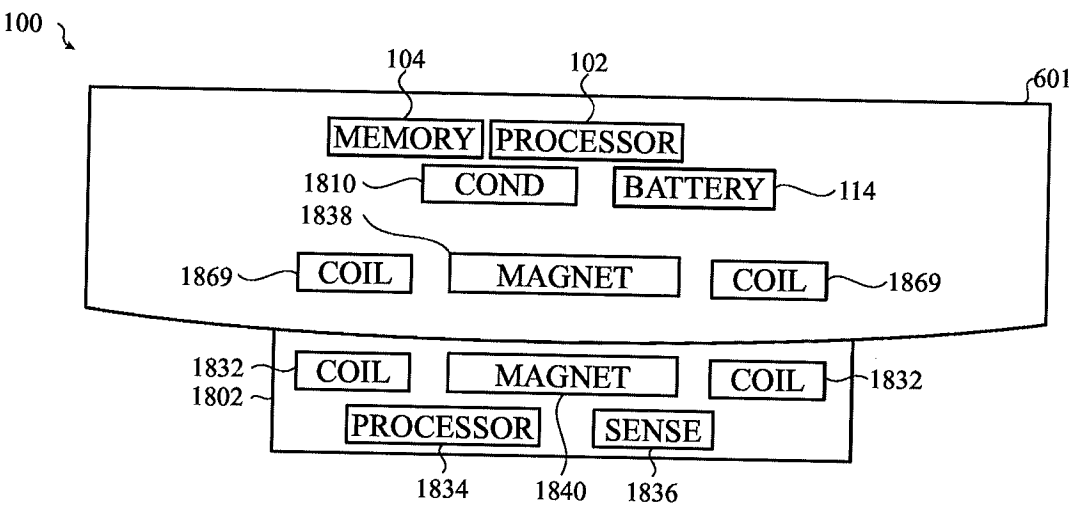


FIG. 19

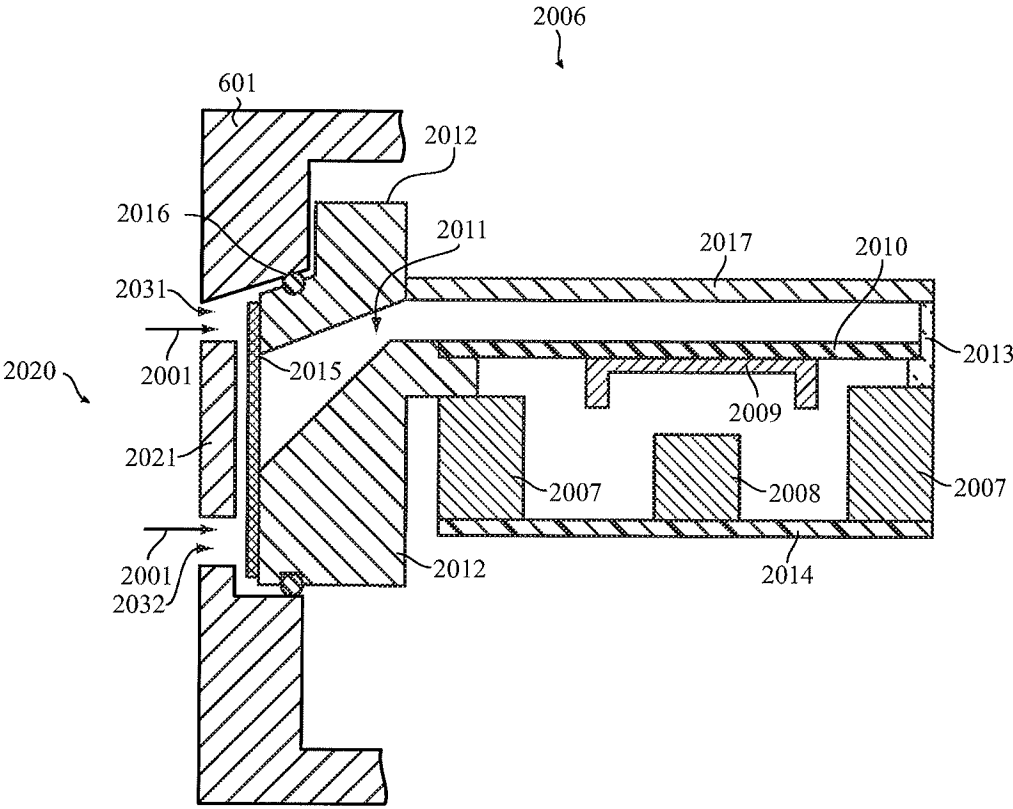


FIG. 20

U.S. Patent

Oct. 18, 2022

Sheet 21 of 26

US 11,474,483 B2

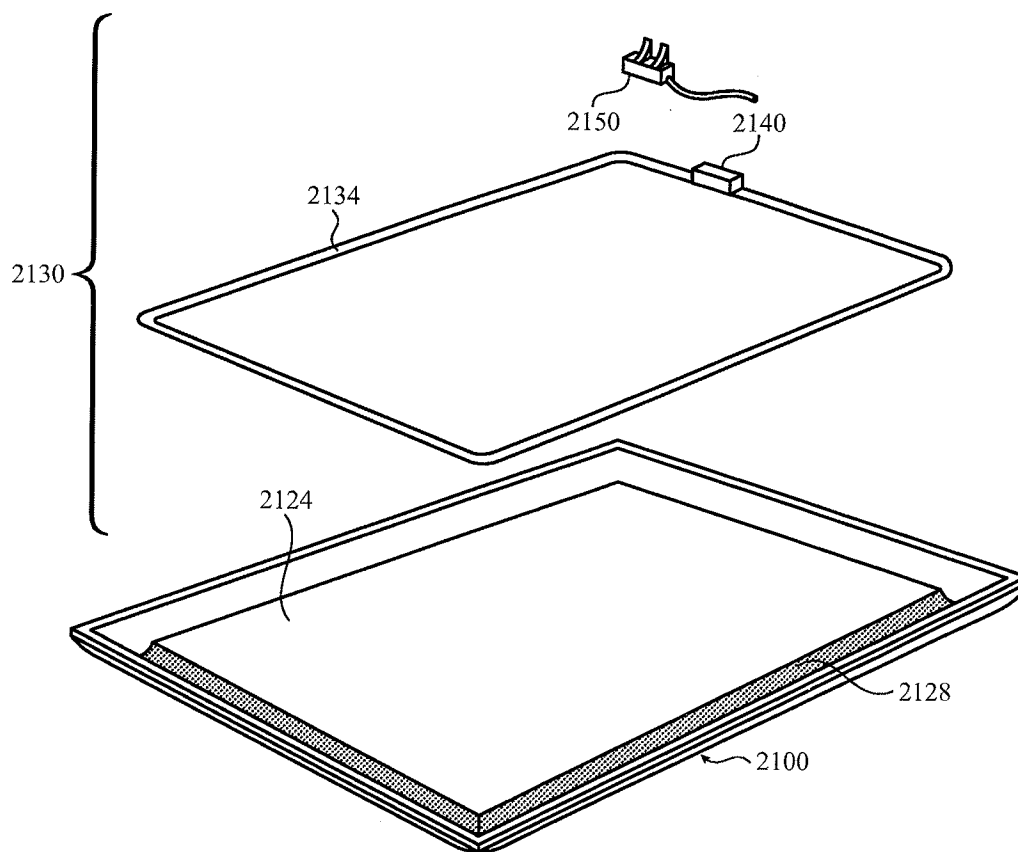


FIG. 21A

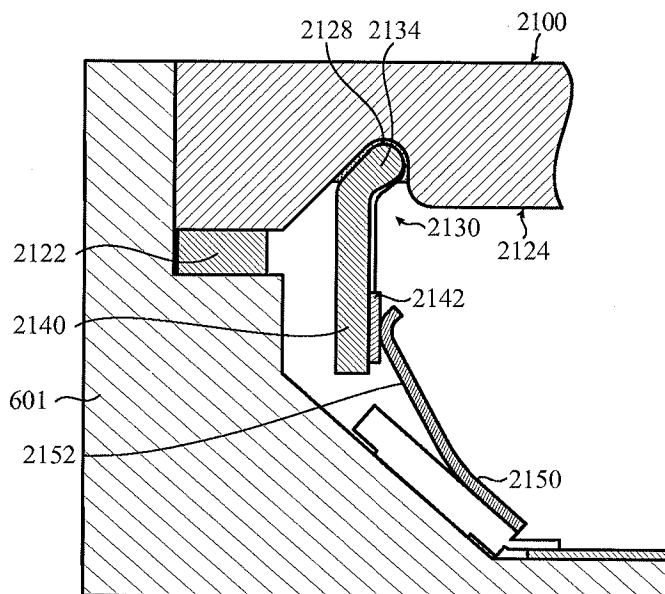


FIG. 21B

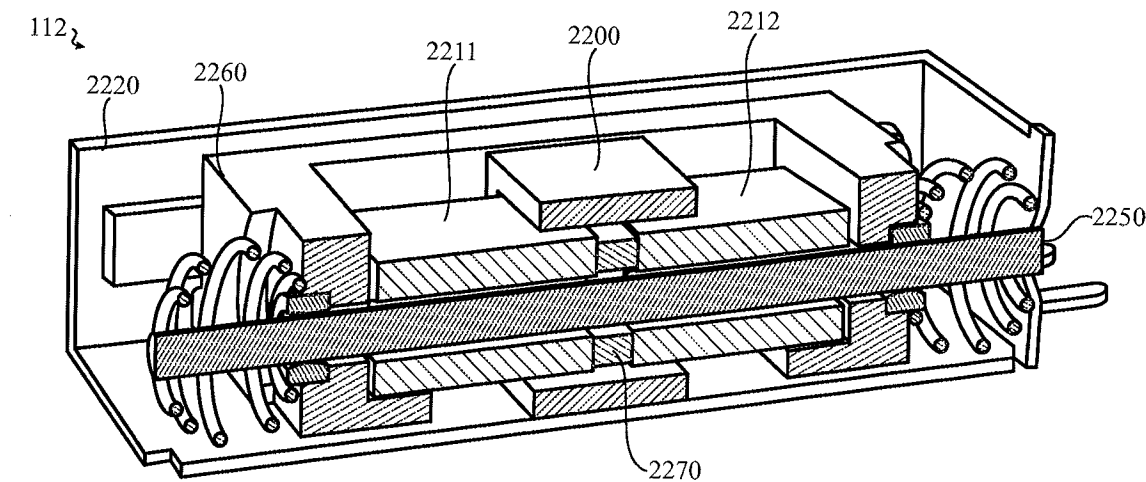


FIG. 22A

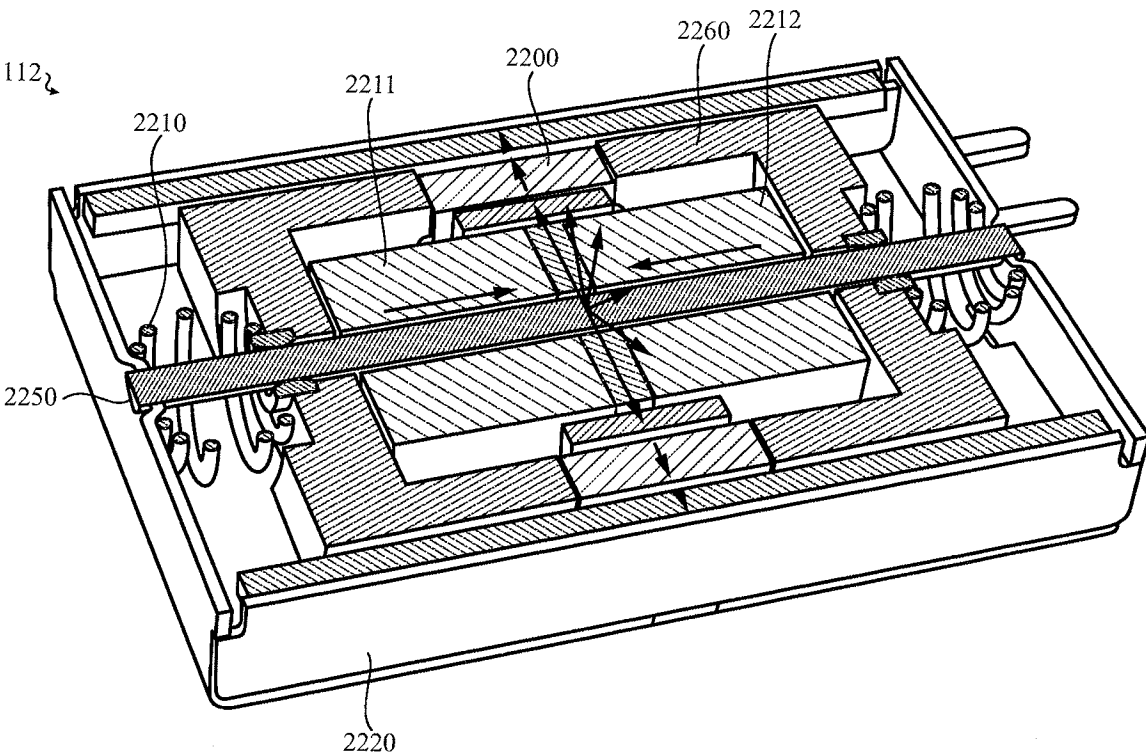


FIG. 22B

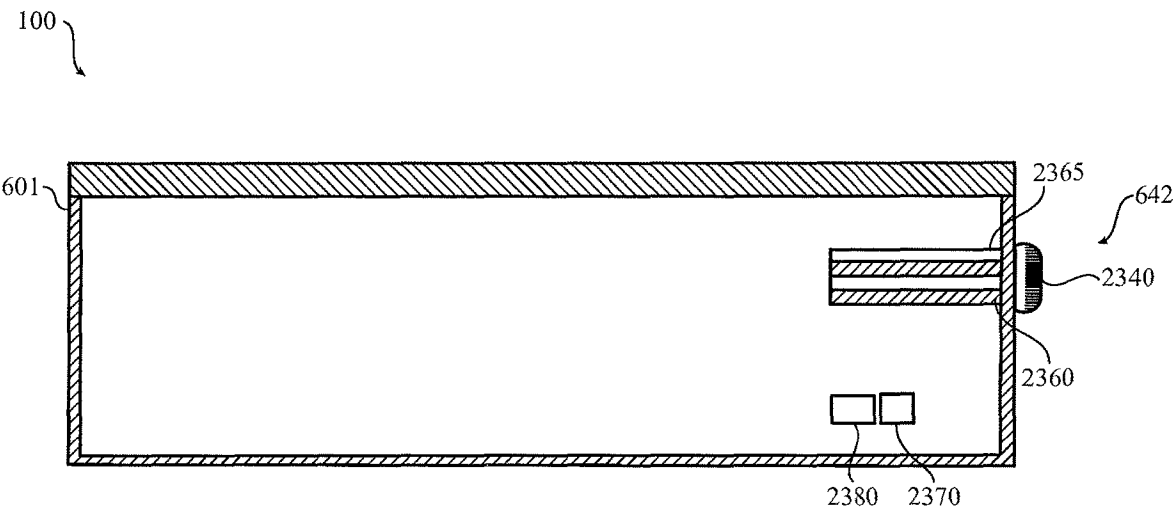


FIG. 23

U.S. Patent

Oct. 18, 2022

Sheet 24 of 26

US 11,474,483 B2

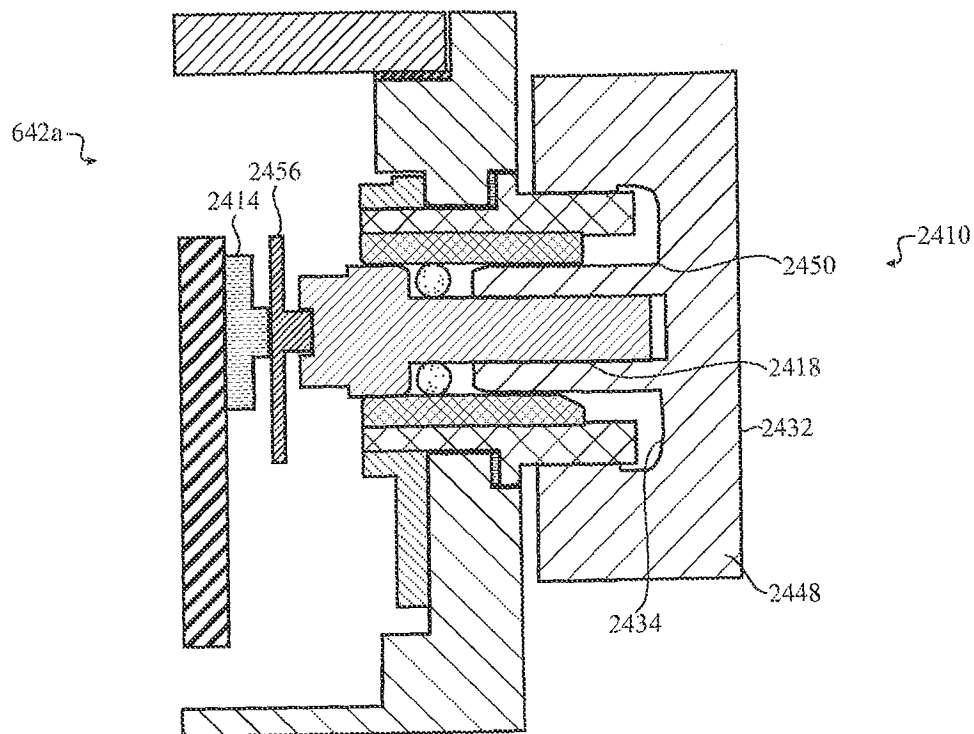


FIG. 24A

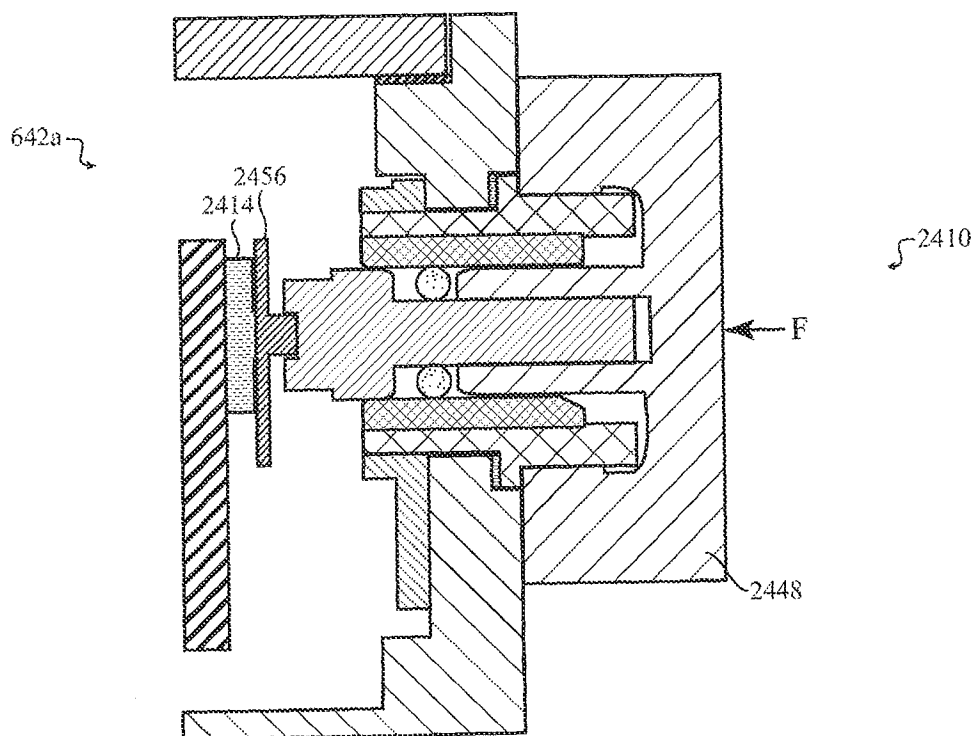


FIG. 24B



U.S. Patent

Oct. 18, 2022

Sheet 25 of 26

US 11,474,483 B2

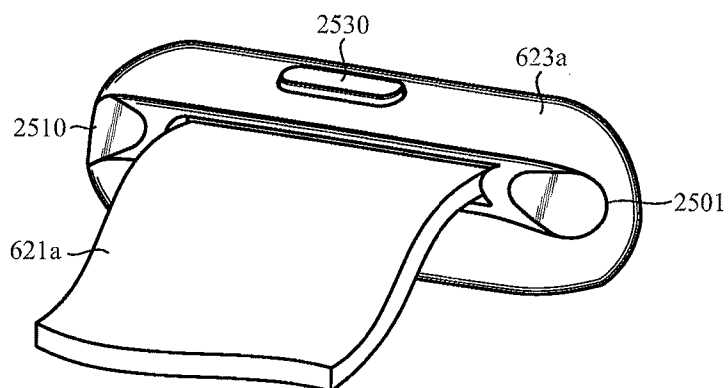


FIG. 25A

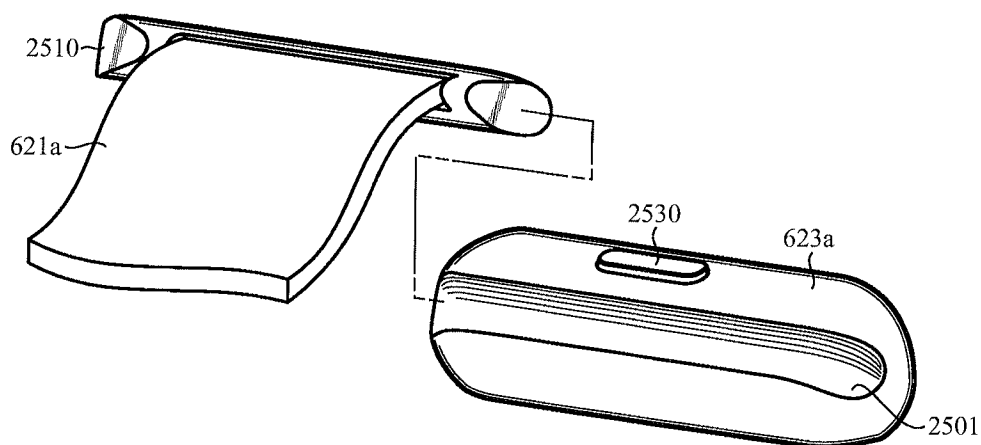


FIG. 25B

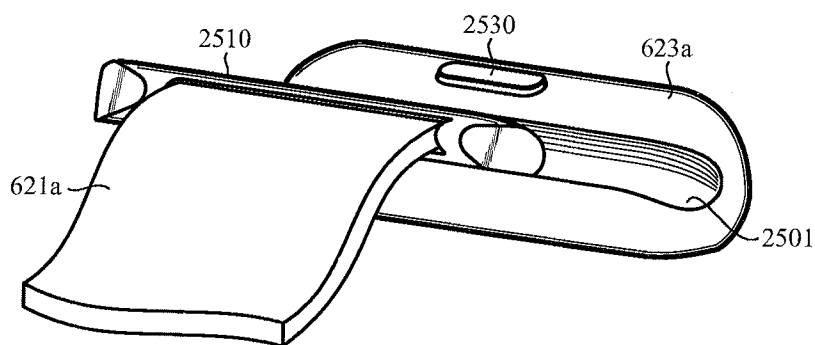


FIG. 25C

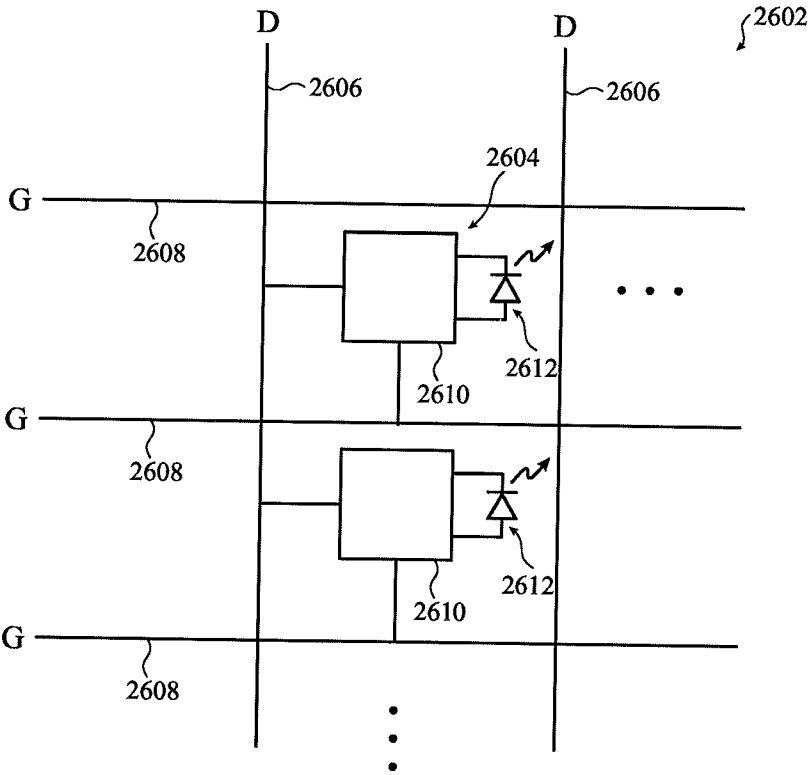


FIG. 26

US 11,474,483 B2

1

**WEARABLE ELECTRONIC DEVICE****CROSS-REFERENCE TO RELATED APPLICATIONS**

This application is a continuation patent application of U.S. patent application Ser. No. 17/188,966, filed Mar. 1, 2021, and titled "Wearable Electronic Device," which is a continuation patent application of U.S. patent application Ser. No. 16/826,130, filed Mar. 20, 2020, and titled "Wearable Electronic Device," now U.S. Pat. No. 10,942,491, issued Mar. 9, 2021, which is a continuation patent application of U.S. patent application Ser. No. 14/842,617, filed Sep. 1, 2015, and titled "Wearable Electronic Device," now U.S. Pat. No. 10,599,101, issued Mar. 24, 2020, which is a nonprovisional patent application of and claims the benefit of U.S. Provisional Patent Application No. 62/044,974, filed Sep. 2, 2014, the disclosures of which are hereby incorporated herein by reference in their entireties. U.S. patent application Ser. No. 16/826,130, filed Mar. 20, 2020, and titled "Wearable Electronic Device," now U.S. Pat. No. 10,942,491, issued Mar. 9, 2021 is also a continuation patent application of U.S. patent application Ser. No. 15/261,917, filed Sep. 10, 2016, and titled "Wearable Electronic Device," now U.S. Pat. No. 10,627,783, issued Apr. 21, 2020, which is a continuation application of U.S. patent application Ser. No. 14/842,617, filed Sep. 1, 2015, and titled "Wearable Electronic Device," now U.S. Pat. No. 10,599,101, issued Mar. 24, 2020, which is a nonprovisional patent application of and claims the benefit of U.S. Provisional Patent Application No. 62/044,974, filed Sep. 2, 2014, the disclosures of which are hereby incorporated herein by reference in their entireties. U.S. patent application Ser. No. 16/826,130, filed Mar. 20, 2020, and titled "Wearable Electronic Device," now U.S. Pat. No. 10,942,491, issued Mar. 9, 2021 is also a continuation patent application of U.S. patent application Ser. No. 15/261,914, filed Sep. 10, 2016, and titled "Wearable Electronic Device," now U.S. Pat. No. 10,613,485, issued Apr. 7, 2020, which is a continuation patent application of U.S. patent application Ser. No. 14/842,617, filed Sep. 1, 2015, and titled "Wearable Electronic Device," now U.S. Pat. No. 10,599,101, issued Mar. 24, 2020, which is a nonprovisional patent application of and claims the benefit of U.S. Provisional Patent Application No. 62/044,974, filed Sep. 2, 2014, the disclosures of which are hereby incorporated herein by reference in their entireties. U.S. patent application Ser. No. 16/826,130, filed Mar. 20, 2020, and titled "Wearable Electronic Device," now U.S. Pat. No. 10,942,491, issued Mar. 9, 2021 is also a continuation patent application of U.S. patent application Ser. No. 15/261,912, filed Sep. 10, 2016, and titled "Wearable Electronic Device," now U.S. Pat. No. 10,620,591, issued Apr. 14, 2020, which is a continuation patent application of U.S. patent application Ser. No. 14/842,617, filed Sep. 1, 2015, and titled "Wearable Electronic Device," now U.S. Pat. No. 10,599,101, issued Mar. 24, 2020, which is a nonprovisional patent application of and claims the benefit of U.S. Provisional Patent Application No. 62/044,974, filed Sep. 2, 2014, the disclosures of which are hereby incorporated herein by reference in their entireties. This application is also a continuation patent application of U.S. patent application Ser. No. 17/188,995, filed Mar. 1, 2021, and titled "Wearable Electronic Device," which is a continuation patent application of U.S. patent application Ser. No. 16/826,130, filed Mar. 20, 2020, and titled "Wearable Electronic Device," now U.S. Pat. No. 10,942,491, issued Mar. 9, 2021, which is a continuation patent application of U.S. patent applica-

2

tion Ser. No. 14/842,617, filed Sep. 1, 2015, and titled "Wearable Electronic Device," now U.S. Pat. No. 10,599,101, issued Mar. 24, 2020, which is a nonprovisional patent application of and claims the benefit of U.S. Provisional Patent Application No. 62/044,974, filed Sep. 2, 2014, the disclosures of which are hereby incorporated herein by reference in their entireties. U.S. patent application Ser. No. 16/826,130, filed Mar. 20, 2020, and titled "Wearable Electronic Device," now U.S. Pat. No. 10,942,491, issued Mar. 9, 2021 is also a continuation patent application of U.S. patent application Ser. No. 15/261,917, filed Sep. 10, 2016, and titled "Wearable Electronic Device," now U.S. Pat. No. 10,627,783, issued Apr. 21, 2020, which is a continuation application of U.S. patent application Ser. No. 14/842,617, filed Sep. 1, 2015, and titled "Wearable Electronic Device," now U.S. Pat. No. 10,599,101, issued Mar. 24, 2020, which is a nonprovisional patent application of and claims the benefit of U.S. Provisional Patent Application No. 62/044,974, filed Sep. 2, 2014, the disclosures of which are hereby incorporated herein by reference in their entireties. U.S. patent application Ser. No. 16/826,130, filed Mar. 20, 2020, and titled "Wearable Electronic Device," now U.S. Pat. No. 10,942,491, issued Mar. 9, 2021 is also a continuation patent application of U.S. patent application Ser. No. 15/261,914, filed Sep. 10, 2016, and titled "Wearable Electronic Device," now U.S. Pat. No. 10,613,485, issued Apr. 7, 2020, which is a continuation patent application of U.S. patent application Ser. No. 14/842,617, filed Sep. 1, 2015, and titled "Wearable Electronic Device," now U.S. Pat. No. 10,599,101, issued Mar. 24, 2020, which is a nonprovisional patent application of and claims the benefit of U.S. Provisional Patent Application No. 62/044,974, filed Sep. 2, 2014, the disclosures of which are hereby incorporated herein by reference in their entireties. U.S. patent application Ser. No. 16/826,130, filed Mar. 20, 2020, and titled "Wearable Electronic Device," now U.S. Pat. No. 10,942,491, issued Mar. 9, 2021 is also a continuation patent application of U.S. patent application Ser. No. 15/261,912, filed Sep. 10, 2016, and titled "Wearable Electronic Device," now U.S. Pat. No. 10,620,591, issued Apr. 14, 2020, which is a continuation patent application of U.S. patent application Ser. No. 14/842,617, filed Sep. 1, 2015, and titled "Wearable Electronic Device," now U.S. Pat. No. 10,599,101, issued Mar. 24, 2020, which is a nonprovisional patent application of and claims the benefit of U.S. Provisional Patent Application No. 62/044,974, filed Sep. 2, 2014, the disclosures of which are hereby incorporated herein by reference in their entireties.

**FIELD**

The following disclosure generally relates to an electronic device, and more specifically to a wearable electronic device having a range of features, including touch input, force input, an interchangeable attachment system, health monitoring functionality, wireless power charging, wireless authentication and transaction functionality, and other features and functionality.

**BACKGROUND**

Portable electronic devices have become increasingly popular, and the features and functionality provided by portable electronic devices continue to expand to meet the needs and expectations of many consumers. However, some traditional portable electronic devices, particularly wearable electronic devices, may have relatively limited functionality or are only able to perform a specialized set of functions or

US 11,474,483 B2

3

tasks. For example, some traditional electronic wristwatches may be configured to perform a relatively limited set of functions, including displaying time, date, and performing basic timing functions. The embodiments described herein are directed to a wearable electronic device that provides a wide range of functionality, as compared to some traditional wearable electronic devices.

## SUMMARY

The embodiments included herein are directed to a consumer product, which may include a portable or wearable electronic device that is configured to provide an expansive feature set integrated or incorporated into a compact form factor. In some aspects of the present disclosure, a consumer product may integrate or combine multiple subsystems into a single device to provide a wide range of functionality, including biometric sensing, touch-based user input, near-field communications, and other desirable features. In some aspects, multiple subsystems are integrated into the relatively compact space of a wrist-worn device.

Some example embodiments are directed to wearable electronic device having a housing that includes a flat bottom portion, a top portion defining a cavity, and a curved side portion that extends from the bottom portion to the top portion. A band may be attached to the housing and configured to secure the wearable electronic device to a user. A display may be at least partially disposed within the cavity and may have a viewable area. The device may also include a cover disposed above the display and including a flat middle portion larger than the viewable area of the display, a curved edge portion surrounding the flat middle portion and coinciding with the curved side portion along a perimeter of the cavity to form a continuous contoured surface.

In some embodiments, the continuous contoured surface is tangent with the flat bottom portion of the housing at a first end of the contour. The continuous contoured surface may also be tangent with the flat middle portion of the cover at a second end of the contour. In some embodiments, the continuous contoured surface has a constant radius.

In some embodiments, the cavity has a rectangular shape. The curved edge portion of the housing may have four sides that surround the cavity, each side is orthogonal to two adjacent sides. Each side may be connected to an adjacent side by a rounded corner. In some embodiments, the rounded corners have a curvature that corresponds to a curvature of the continuous contoured surface formed by the curved edge portion of the cover and the curved side portion of the housing.

Some embodiments include a crown module that is positioned at least partially within an aperture formed within the curved side portion of the housing. The crown module may include an outer surface configured to receive a rotary user input. The crown module may be offset with respect to a centerline of the housing between the top portion and the flat bottom portion. The offset may be toward the top portion of the housing. The crown module may include a dial having a portion that is higher than an interface between the cover and the housing.

In some example embodiments, a port is formed in the curved side portion of the housing. An acoustic module may be disposed within the housing and configured to produce an audio output through the port. The acoustic module may include an acoustic element and an acoustic cavity that acoustically couples the acoustic element to the port. The

4

port may include an orifice that is offset with respect to the acoustic cavity to prevent the direct ingress of liquid into the acoustic module.

In some embodiments, the device includes a gasket positioned between the housing and the cover. The housing may also include a ledge formed along a perimeter of the cavity. The gasket may be positioned along the ledge that is formed along the perimeter of the cavity. The gasket, the cover, and the housing may be configured to cooperate to form a substantially water-proof seal.

In some example embodiments, the device includes a biosensor module that is disposed in an opening formed in the flat bottom portion of the housing. The biosensor module may include a chassis positioned in the opening of the housing and defining an array of windows. An array of light sources may be attached to the chassis and configured to emit light into the user through the array of windows. The biosensor module may also include an optically transparent rear cover disposed over the chassis and over the array of windows and operative to pass light emitted from the array of light sources into the user. In some embodiments, the rear cover has a convex outer contour.

Some example embodiments are directed to an electronic device having a housing comprising a bottom portion defining an opening and a band attached to the housing and configured to secure the electronic device to a user. A biosensor module may be disposed within the opening of the housing. A rear cover may be disposed over the biosensor module and may include an edge protruding outwardly from the bottom portion of the housing and an outer surface having a convex curved contour. In some embodiments, the outer surface of the rear cover defines one or more windows that provide operational access to one or more optical components of the biosensor module. The one or more windows may have a curvature that matches the convex curved contour of the outer surface.

In some embodiments, the biosensor module includes an array of light sources that are configured to emit light into a body of the user. The biosensor module may also include a photodetector configured to receive light produced by a light source of the array of light sources that is reflected from the body and produce a sensor signal. In some cases, the biosensor module is removably coupled to the housing.

In some embodiments, the device also includes a processing unit configured to compute a health metric associated with the user based on the sensor signal. The device may also include a display disposed within the housing and configured to display the health metric.

Some example embodiments are directed to a wearable electronic device, having a housing including a top portion, a cavity formed within the top portion, and a curved side portion that surrounds the cavity. The device may also include a transparent cover disposed over the cavity of the housing and may include a flat middle portion at a center of the transparent cover, a curved outer portion that emanates from and surrounds the flat middle portion and extends outwardly to an edge of the transparent cover, and a mask positioned relative to an internal surface of the transparent cover. The mask may have an outer boundary located proximate to the edge of the transparent cover and an inner boundary located within the curved outer portion of the transparent cover.

In some embodiments, the device includes a display disposed below the transparent cover. A perimeter portion of a viewable area of the display may be disposed below the mask. The device may also include an antenna having a shape that corresponds to a shape of the cavity formed



## US 11,474,483 B2

5

within the housing. The antenna may be disposed in a groove formed in the internal surface of the transparent cover. The groove may be formed between the outer boundary and the inner boundary of the mask. In some embodiments, the cover is formed from a sapphire material. The antenna may be configured to facilitate wireless communication between the wearable electronic device and an external device.

Some example embodiments are directed to an electronic device having a housing including a first end, a second end opposite the first end, a first side extending between the first and second ends, and a second side opposite to the first side and extending between the first and second ends. The first end may define a first groove extending between the first and second sides and may be configured to receive a first lug portion of a first band. The second end may define a second groove extending between the first and second sides and may be configured to receive a second lug portion of a second band. The first and second grooves may have an inwardly curved concave shape with an undercut feature that retains the first and second lug portions. In some embodiments, the first groove extends through a solid portion of the housing to form a continuous interior shape.

In some embodiments, the device includes a display at least partially disposed within a cavity of the housing. A cover may be disposed above the display and at least a portion of the first groove is disposed below the cover. The first and second grooves may be formed at an angle with respect to a centerline of the housing. The first and second grooves may be angled upward toward a top of the housing and inward toward the center of the housing. The first and second grooves may cross the centerline of the housing.

Some example embodiments are directed to a wearable electronic device including a housing and a band attached to the housing and configured to secure the wearable electronic device to a user. A crown may be disposed relative to the housing and configured to receive a rotational input. An encoder may be operatively coupled to the crown and configured to produce an encoder output that corresponds to the rotational input. A speaker module may be disposed within the housing and configured to produce an audio output that corresponds to the encoder output. A haptic device may be disposed within the housing and configured to produce a haptic output that corresponds to the encoder output. In some embodiments, the haptic output is synchronized with the audio output. The crown may be further configured to translate along an axis and actuate a tactile switch.

In some embodiments, the device also includes a display element within the housing. The device may be configured to display a list of items on the display element and scroll the list of items in response to the encoder output. The device may also be configured to synchronize the audio and haptic outputs with the scrolling of the list of items. In some embodiments, the crown is further configured to translate along an axis and actuate a tactile switch. The crown may be operative to select an item of the list of items when the tactile switch is actuated.

Some example embodiments are directed to a wearable electronic device having a housing that includes a bottom portion and an aperture formed in the bottom portion. A band may be attached to the housing and configured to secure the wearable electronic device to a user. A biosensor module may be disposed in the aperture of the housing. The biosensor module may include an array of light sources configured to emit light into a body of the user, and a photodetector configured to receive light produced by a light source of the array of light sources that is reflected from the

6

body and produce a sensor signal. The device may also include a processing unit that is configured to compute a health metric associated with the user based on the sensor signal. A display may be disposed within the housing and configured to display the health metric.

In some embodiments, the array of light sources and the photodetector are configured to function as multiple photoplethysmography (PPG) sensors. Each PPG sensor may be configured to be used to compute a separate health metric. In some embodiments, a first light source of the array of light sources includes a green LED adapted to detect blood perfusion in the body. A second light source of the array of light sources may include an infrared LED adapted to detect water content of the body. The health metric may include one or more of: a heart rate, a respiration rate, a blood oxygenation level, and a blood volume estimate.

In some embodiments, the device also includes at least one pair of electrodes disposed on an exterior surface of the housing. The at least one pair of electrodes may be configured to produce a signal when the at least one pair of electrodes is in contact with the body. In some case, the signal is used to compute an additional health metric that includes one or more of: a heart function, a body fat estimate, and a body fat estimate.

Some example embodiments are directed to a wearable electronic device including a housing and a band attached to the housing and configured to secure the wearable electronic device to a user. The device may also include an array of light emitting diodes (LEDs) disposed within the housing, the array of LEDs being configured to emit light. A photodetector may be disposed within the housing and configured to receive light produced by an LED of the array of LEDs that is reflected from a body of the user and produce a first sensor signal in response to the received light. The device may also include at least one pair of electrodes disposed on an exterior surface of the wearable electronic device. The electrodes may be configured to produce a second sensor signal when the electrodes are in contact with a respective portion of the body. The device may also include a processing unit that is configured to compute one or more health metrics based on the first and second sensor signals. The device may also include a display disposed at least partially within the housing and configured to display the one or more health metrics.

Some example embodiments are directed to a wearable electronic device including a housing and a band attached to the housing and configured to secure the wearable electronic device to a user. A cover may be disposed relative to the housing and a display may be attached to a lower surface of the cover. A force sensor may be positioned between the cover and the housing and attaching the cover to the housing. The force sensor may be configured to detect the force of a touch on the cover. The force sensor may also form a barrier to prevent ingress of liquid into the wearable electronic device. In some embodiments, an antenna may be disposed relative to the cover and external from the housing. The antenna may be configured to facilitate wireless communication with an external device.

In some example embodiments, a wearable electronic device may include a housing and a band attached to the housing and configured to secure the wearable electronic device to a user. A display element may be positioned within the housing and a rechargeable battery may be disposed within the housing and operatively coupled to the display element. The device may also include a receive coil within the housing configured to inductively couple with an external transmit coil. A power conditioning circuit may be

US 11,474,483 B2

7

configured to recharge the rechargeable battery using power received by the receive coil. The power conditioning circuit may be configured to provide power to the display element. The device may also include a first alignment magnet positioned within the receive coil and configured to align the device with respect to a second alignment magnet positioned within the external transmit coil.

Some example embodiments are directed to a wearable electronic device that includes a housing and a band attached to the housing and configured to secure the wearable electronic device to a user. A cover may be positioned relative to the housing and a display may be disposed within the housing and below the cover. A force sensor may be disposed within the housing and configured to detect a force of a touch on the cover. A touch sensor may be disposed between the display and the cover. The touch sensor may be configured to detect a location of the touch on the cover. In some embodiments, the force sensor is disposed along a perimeter of the display. The device may also include a processing unit and memory disposed within the housing. The processing unit may be configured to interpret a touch gesture on a surface of the cover using a force output from the force sensor and a touch output from the touch sensor.

#### BRIEF DESCRIPTION OF THE DRAWINGS

The disclosure will be readily understood by the following detailed description in conjunction with the accompanying drawings, wherein like reference numerals designate like structural elements.

FIG. 1 depicts an example wearable electronic device having a device body and band.

FIG. 2 depicts an example schematic diagram of a wearable electronic device.

FIG. 3 depicts an example functional diagram for a wearable electronic device.

FIG. 4 depicts an example wearable electronic device as part of a system of devices.

FIG. 5 depicts a system of interchangeable components for a wearable device.

FIG. 6 depicts an example wearable electronic device having a device body and band.

FIG. 7 depicts an exploded view of components of an example wearable electronic device.

FIG. 8 depicts an example housing for a wearable electronic device.

FIG. 9 depicts an example force sensor configured to use a capacitive measurement.

FIGS. 10A-B depict plan views of example force sensors.

FIG. 11 depicts an example force sensor configured to use a resistive measurement.

FIG. 12 depicts an example pixelated force sensor configured to use a resistive measurement.

FIGS. 13A-B depict example force sensor structures.

FIGS. 14A-C depict an example touch sensor based on mutual capacitance.

FIGS. 15A-B depict an example touch sensor based on self capacitance.

FIG. 16 depicts an example device having biosensors.

FIG. 17 depicts an example device having wireless communications with an external device.

FIG. 18 depicts an example electronic device and example dock of an inductive charging system.

FIG. 19 depicts a block diagram of an example inductive charging system.

FIG. 20 depicts an example acoustic module.

FIGS. 21A-B depict an example cover and antenna.

8

FIGS. 22A-B depict an example haptic module.

FIG. 23 depicts an example device having a crown module with an encoder.

FIGS. 24A-B depict an example device having a crown module with a tactile switch.

FIGS. 25A-C depict an example receiving feature for a band.

FIG. 26 depicts example elements of a display.

#### DETAILED DESCRIPTION

Provided herein are descriptions and examples of a consumer product, which may include a portable electronic device, a wearable electronic device, or other type of device. By way of example and not by way of limitation, the consumer product may be an electronic device, a mechanical device, or an electromechanical device. Specific example devices include mobile phones, personal digital assistants, music players, timekeeping devices, health monitoring devices, tablet computers, laptop computers, glasses (electronic or otherwise), portable storage devices, and the like.

In one particular embodiment, the consumer product is a portable and, more specifically, a wearable consumer product. A wearable consumer product is one that can be worn by or otherwise secured to a user. For example, the consumer product may be a wearable electronic device including, but not limited to, a wearable computer, a wearable watch, a wearable communication device, a wearable media player, a wearable health monitoring device, and the like. A wearable consumer product may be worn by a user in a variety of ways. In some examples, the consumer product is a wrist-worn product and may include a band that can be wrapped around a user's wrist to secure the consumer product to the user's body. The device may include one or more other types of attachments including, for example, an armband, lanyard, waistband, chest strap, and the like.

Some aspects of the disclosure are directed to a wearable electronic device having improved functionality and/or versatility as compared to some traditional wearable devices. For example, some aspects of the disclosure are directed to a consumer product, such as a portable electronic device, having an expansive feature set integrated or incorporated into a compact form factor. In some aspects of the present disclosure, a consumer product may integrate or combine multiple subsystems into a single device to provide a wide range of functionality, including biometric sensing, touch-based user input, near-field communications, and other desirable features. In some aspects, multiple subsystems are integrated into the relatively compact space of a wrist-worn device. Some aspects of the following disclosure are directed to the integration of a variety of subsystems or modules to provide functionality that may not be possible using some traditional device platforms. In some cases, the configuration and/or functionality provided by the various subsystems may be configurable by the end user, the manufacturer, and/or a vendor of the device. Example subsystems or modules of a consumer product and their respective functions are described below with respect to FIGS. 2 and 3.

Some aspects of the disclosure are directed to a consumer product that is configured to communicate wirelessly with any of a number of other devices, such as a mobile phone, computer, tablet computing devices, personal media players, televisions, networked home appliances, networked home controls, electronic systems in vehicles, and so on. Through wireless communication with other devices, the consumer product may transmit and/or receive various notifications, messages, or other information between devices. The wire-



US 11,474,483 B2

9

less communication may also facilitate the relay of alerts or other device outputs to notify the user of an event or action. In some aspects, the consumer product may communicate wirelessly with any of a number of electronic accessories, including headset devices, portable speaker devices, portable microphone devices, display screens, and so on. An example communication system is described below with respect to FIG. 4 and with respect to other examples provided herein.

In some aspects, the consumer product may include a system of interchangeable components used to attach or secure the consumer product to the user. The system of interchangeable components may include a set of interchangeable bands or attachment devices that are configured to connect or attach to a receiving feature on the body of the product. The receiving feature may be standardized within the system of interchangeable components and allow multiple types of bands or attachment devices to be used with the same housing or body. The system of interchangeable components may also allow for an interchange between different bodies, which may include different types of electronic devices or other consumer products. Each body of the different devices or products may have a similar receiving feature that is standardized within the system of interchangeable components. An example system of interchangeable components is described below with respect to FIG. 5 and with respect to other examples provided herein.

Some aspects of the present disclosure are directed to a consumer product that includes a body that includes a case or housing used to protect as well as support the internal components of the product in their assembled position. The housing may enclose and support various components, including, for example, integrated circuits, subsystems, modules, and other internal components of the device. In some aspects, the housing forms a water-resistant or waterproof barrier and also provides structural rigidity necessary to protect internal components. The housing may be formed as a single piece, which may enhance the structural rigidity, water impermeability, and manufacturability of the housing. An example housing and example internal components for a consumer product are provided below with respect to FIGS. 6-8 and with respect to other examples provided herein.

In some aspects, the consumer product includes a force sensor that is configured to detect and measure the magnitude of a force or pressure on a surface of the product. In some implementations, the force sensor includes a capacitive-based sensor that is configured to estimate the force based on a deflection or movement between capacitive plates that is caused by and correlates to the amount of force caused by a touch. In some implementations, the force sensor is a resistance- or charge-based sensor that is configured to estimate the force based on the deflection of a sheet or film that is positioned relative to the touch-sensitive surface of the product. In some implementations, the output from the force sensor is combined with the output from a touch sensor, which may be self-capacitive or mutually capacitive, or a combination of the two. Example force and touch sensors are described below with respect to FIGS. 9-15B and with respect to other examples provided herein.

In some aspects, the consumer product includes one or more biosensors. The biosensors may include optical and/or electronic biometric sensors that may be used to compute one or more health metrics. Example health metrics include, without limitation, a heart rate, a respiration rate, blood oxygenation level, a blood volume estimate, blood pressure, or a combination thereof. In some embodiments, the biosensors include an electrical sensor that may be used to

10

measure electrocardiographic (ECG) characteristics, galvanic skin resistance, and other electrical properties of the user's body. An example consumer product having multiple biosensors is described below with respect to FIG. 16 and with respect to other examples herein.

In some aspects, the consumer product is configured to perform wireless communication with an external device. In some implementations, the wireless communication may include a Near Field Communication (NFC) interface. The NFC interface may be used to identify the device and initiate a secure data connection, which may be used to authorize transactions, purchases, or conduct other forms of e-commerce. An example consumer product having wireless communications with an external device is described in more detail below with respect to FIG. 17 and with respect to other examples herein.

In some aspects, the consumer product is configured to recharge an internal battery using a wireless charging system. In some implementations, the consumer product includes one or more receiving inductive coils that are configured to cooperate with one or more transmitting inductive coils that are located in a charging dock or other external device. The wireless charging system may allow the transfer of power and/or wireless communications with the consumer product without the use of an external port or terminal connection. An example consumer product having wireless charging capabilities is described in more detail below with respect to FIGS. 18-19 and with respect to other examples herein.

In some aspects, the consumer product includes one or more acoustic modules that are configured to function as a speaker and/or a microphone for the product. The speaker and/or microphone may include features that enhance the water/liquid resistance or impermeability of the consumer product. The consumer product may also include a haptic module or actuator that is configured to produce a haptic output that may be perceived by the user. In some implementations, the output of an acoustic module, such as a speaker, and the haptic module may be used to provide feedback or an alert to the user. In some cases, an acoustic module and the haptic module provide feedback to the user and may be coordinated with a user input, such as user-interface selecting, user-interface scrolling, or other user input command. An example acoustic module is described below with respect to FIG. 20 and an example haptic module is described below with respect to FIGS. 22A-B.

In some aspects, the consumer product includes a dial or crown that is coupled to an encoder or other rotary sensor for detecting a rotary input. In some implementations, the output from the optical encoder is used to drive an aspect of a user interface or control other functionality of the product. Additionally, the dial or crown may include a tactile switch that can be actuated by pressing inward on the dial or crown. An example consumer product having a crown is described below with respect to FIGS. 23-24B and with respect to other examples herein.

The description that follows includes sample devices, components, modules, systems, methods, and apparatuses that embody various elements of the present disclosure. However, it should be understood that various elements of the described disclosure may be combined and/or practiced in a variety of forms in addition to those described herein. In particular, the modules and components are described in a particular combination with respect to some examples provided below. However other combinations are possible,

## US 11,474,483 B2

11

which may be achieved by adding, removing, and/or rearranging modules to obtain a device or system having the desired characteristics.

FIG. 1 depicts a wearable consumer product 10. For example, the consumer product 10 may be a wearable electronic device. In one example, the consumer product 10 may be a wearable multifunctional electronic device including multiple functionalities such as time keeping, health monitoring, sports monitoring, medical monitoring, communications, navigation, computing operations, and/or the like. The functionalities may include but are not limited to: keeping time; monitoring a user's physiological signals and providing health-related information based on those signals; communicating (in a wired or wireless fashion) with other electronic devices or services, which may be different types of devices having different functionalities; providing alerts to a user, which may include audio, haptic, visual and/or other sensory output, any or all of which may be synchronized with one another; visually depicting data on a display; gathering data from one or more sensors that may be used to initiate, control, or modify operations of the device; determining a location of a touch on a surface of the device and/or an amount of force exerted on the device, and using either or both as input; accepting voice input to control one or more functions; accepting tactile input to control one or more functions; capturing and transmitting images; and so on. These and other functions and features will be described in more detail herein.

The wearable consumer product 10 can take a variety of forms. In one example, the consumer product 10 may be a wrist-worn electronic device. The device may include a variety of types of form factors including, wristbands, armbands, bracelets, jewelry, and/or the like.

In the illustrated embodiment, the consumer product 10 includes a device body 11. The device body 11 may include a housing that carries, encloses and supports both externally and internally various components (including, for example, integrated circuit chips and other circuitry) to provide computing and functional operations for the consumer product 10. The components may be disposed on the outside of the housing, partially within the housing, through the housing, completely inside the housing, and the like. The housing may, for example, include a cavity for retaining components internally, holes or windows for providing access to internal components, and various features for attaching other components. The housing may also be configured to form a water-resistant or water-proof enclosure for the body 11. For example, the housing may be formed from a single unitary body and the openings in the unitary body may be configured to cooperate with other components to form a water-resistant or water-proof barrier.

Examples of components that may be contained in the device body 11 include processing units, memory, display, sensors, biosensors, speakers, microphones, haptic actuators, batteries, and so on. In some cases, the device body 11 may take on a small form factor. In cases such as these, the components may be packaged and/or in order to provide the most functionality in the smallest space. The components may also be configured to take up a minimal amount of space, which may facilitate the device body 11 having a small form factor. Additionally, the integration and assembly of the various components may be configured to enhance the reliability of the consumer product 10.

The construction of the housing of the device body 11 may be widely varied. For example, housing may be formed from a variety of materials including plastic, rubber, wood, silicone, glass, ceramics, fiber composites, metal or metal

12

alloys, (e.g., stainless steel, aluminum), precious metals (e.g., gold, silver), or other suitable materials, or a combination of these materials.

Also in the illustrated embodiment, the wearable electronic device includes a band 12 or strap or other means for attaching to a user. The band 12 may, for example, be configured to attach to the body and provide a loop for securing to the wrist of the user. The band 12 may be integral with the housing or it may be a separate part. If integral, the band 12 may be a continuation of the housing. In some cases, the integral band may be formed from the same material as the housing. If the band 12 is separate, the band may be fixed or releasably coupled to the housing. In both cases, the band 12 may be formed from similar or different materials as the housing. In most cases, the band 12 is formed from a flexible material such that it can conform to a user's body. Furthermore, the band 12 itself may be a single integral part or it may include attachment ends that provide an open and closed configuration. The attachment ends may, for example, be manifested as a clasp or other similar attachment mechanism or device. This particular configuration allows a user to open the band 12 for placement on the arm and close the band 12 in order to secure the band and body to the arm. The band 12 may be widely varied. By way of example, they may be formed from rubber, silicone, leather, metal, mesh, links and/or the like.

FIG. 2 depicts an example schematic diagram of a wearable electronic device. By way of example, device 100 of FIG. 2 may correspond to the consumer product 10 shown in FIG. 1. To the extent that multiple functionalities, operations, and structures are disclosed as being part of, incorporated into, or performed by device 100, it should be understood that various embodiments may omit any or all such described functionalities, operations, and structures. Thus, different embodiments of the device 100 may have some, none, or all of the various capabilities, apparatuses, physical features, modes, and operating parameters discussed herein.

As shown in FIG. 2, the device 100 includes one or more processing units 102 that are configured to access a memory 104 having instructions stored thereon. The instructions or computer programs may be configured to perform one or more of the operations or functions described with respect to the device 100. For example, the instructions may be configured to control or coordinate the operation of a display 120, one or more input/output components 106, one or more communication channels 108, one or more sensors 110, a speaker 122, a microphone 124 and/or one or more haptic feedback devices 112.

The processing units 102 of FIG. 2 may be implemented as any electronic device capable of processing, receiving, or transmitting data or instructions. For example, the processing units 102 may include one or more of: a microprocessor, a central processing unit (CPU), an application-specific integrated circuit (ASIC), a digital signal processor (DSP), or combinations of such devices. As described herein, the term "processor" is meant to encompass a single processor or processing unit, multiple processors, multiple processing units, or other suitably configured computing element or elements.

The memory 104 can store electronic data that can be used by the device 100. For example, a memory can store electrical data or content such as, for example, audio and video files, documents and applications, device settings and user preferences, timing and control signals or data for the various modules, data structures or databases, and so on. The memory 104 can be configured as any type of memory. By

US 11,474,483 B2

13

way of example only, the memory can be implemented as random access memory, read-only memory, Flash memory, removable memory, or other types of storage elements, or combinations of such devices.

In the schematic diagram of FIG. 2, the one or more input components 106 are represented as a single item within the schematic diagram. However, input components 106 may represent a number of different input components, including buttons, switches, and dials for accepting user input, and so on. More specifically, the input components 106 may correspond to the buttons, dials, crowns or other devices for receiving input. Generally, the input components 106 are configured to translate a user-provided input into a signal or instructions that may be accessed using instructions executed on the processing units 102. In the present example, the input components 106 may include the hardware configured to receive the user input (e.g., button, switch, crown, and encoder) which is operatively coupled to circuitry and firmware used to generate signals or data that are able to be accessed using processor instructions. Each input component 106 may include specialized circuitry for generating signals or data and, additionally or alternatively, circuitry and firmware for generating signals or data may be shared between multiple input components 106. In some cases, the input components 106 produce user-provided feedback for application-specific input that corresponds to a prompt or user interface object presented on display 120. For example, the crown (item 642 of FIG. 6) may be used to receive rotational input from the user, which may be translated into an instruction to scroll a list or object presented on the display 120. The input components 106 may also produce user input for system-level operations. For example the input components 106 may be configured to interact directly with hardware or firmware being executed on the device 100 for system-level operations, including, without limitation, power on, power off, sleep, awake, and do-not-disturb operations.

As shown in FIG. 2, the device 100 may also include one or more acoustic elements, including a speaker 122 and a microphone 124. The speaker 122 may include drive electronics or circuitry and may be configured to produce an audible sound or acoustic signal in response to a command or input. Similarly, the microphone 124 may also include drive electronics or circuitry and is configured to receive an audible sound or acoustic signal in response to a command or input. The speaker 122 and the microphone 124 may be acoustically coupled to respective ports or openings in the housing that allow acoustic energy to pass, but may prevent the ingress of liquid and other debris. As shown in FIG. 2, the speaker 122 and microphone 124 are also operatively coupled to the processing units 102, which may control the operation of the speaker 122 and microphone 124. In some cases, the processing units 102 are configured to operate the speaker 122 to produce an acoustic output that corresponds to an application or system-level operation being performed on the device 100. In some cases, the speaker 122 is operatively coupled to other modules, including, for example, input components 106, such as a crown or button. In some implementations, the device 100 is configured to produce an audible output that corresponds to the operation of the crown or buttons using the speaker 122. The microphone 124 may be configured to produce an output or signal in response to an acoustic stimulus. For example, the microphone 124 may be operatively coupled to the memory 104 and may be configured to record audio input, including human speech, music, or other sounds. In some cases, the

14

microphone 124 may be configured to receive voice signals, which may be interpreted as voice commands by the processing units 102.

The one or more communication channels 108 may include one or more wireless interface(s) that are adapted to provide communication between the processing unit(s) 102 and an external device. In general, the one or more communication channels 108 may be configured to transmit and receive data and/or signals that may be interpreted by instructions executed on the processing units 102. In some cases, the external device is part of an external communication network that is configured to exchange data with wireless devices. Generally, the wireless interface may include, without limitation, radio frequency, optical, acoustic, and/or magnetic signals and may be configured to operate over a wireless interface or protocol. Example wireless interfaces include radio frequency cellular interfaces, fiber optic interfaces, acoustic interfaces, Bluetooth interfaces, infrared interfaces, USB interfaces, Wi-Fi interfaces, TCP/IP interfaces, network communications interfaces, or any conventional communication interfaces.

In some implementations, the one or more communications channels 108 may include a dedicated wireless communication channel between the device 100 and another user device, such as a mobile phone, tablet, computer, or the like. In some cases, output, including audio sounds or visual display elements, are transmitted directly to the other user device for output to the user. For example, an audible alert or visual warning may be transmitted to a user's mobile phone for output on that device. Similarly, the one or more communications channels 108 may be configured to receive user input provided on another user device. In one example, the user may control one or more operations on the device 100 using a user interface on an external mobile phone, tablet, computer, or the like.

Additionally, as described in more detail below with respect to FIG. 17, the communications channels 108 may include a Near Field Communication (NFC) interface. The NFC interface may be used to identify the device and initiate a secure data connection, which may be used to authorize transactions, purchases, or conduct other forms of e-commerce.

As shown in FIG. 2, the device 100 also includes one or more sensors 110 represented as a single item within the schematic diagram. However, the sensors 110 may represent a number of different sensors, including devices and components that are configured to detect environmental conditions and/or other aspects of the operating environment. Example sensors 110 include an ambient light sensor (ALS), proximity sensor, temperature sensor, barometric pressure sensor, moisture sensor, and the like. Thus, the sensors 110 may also be used to compute an ambient temperature, air pressure, and/or water ingress into the device. In some embodiments, the sensors 110 may include one or more motion sensors for detecting movement and acceleration of the device 100. The one or more motion sensors may include one or more of the following: an accelerometer, a gyroscope, a tilt sensor, or other type of inertial measurement device.

The device 100 also includes one or more biosensors 118 and may include optical and/or electronic biometric sensors that may be used to compute one or more health metrics. As described in more detail below with respect to FIG. 16, one or more of the biosensors 118 may include a light source and a photodetector to form a photoplethysmography (PPG) sensor. The optical (e.g., PPG) sensor or sensors may be used to compute various health metrics including, without limitation, a heart rate, a respiration rate, blood oxygenation



US 11,474,483 B2

15

level, a blood volume estimate, blood pressure, or a combination thereof. One or more of the biosensors 118 may also be configured to perform an electrical measurement using one or more electrodes. The electrical sensor(s) may be used to measure electrocardiographic (ECG) characteristics, galvanic skin resistance, and other electrical properties of the user's body. Additionally or alternatively, one or more of the biosensors 118 may be configured to measure body temperature, exposure to UV radiation, and other health-related information.

The device 100 may also include one or more haptic devices 112. The haptic device 112 may include one or more of a variety of haptic technologies such as, but not necessarily limited to, rotational haptic devices, linear actuators, piezoelectric devices, vibration elements, and so on. In general, the haptic device 112 may be configured to provide punctuated and distinct feedback to a user of the device. More particularly, the haptic device 112 may be adapted to produce a knock or tap sensation and/or a vibration sensation. As shown in FIG. 2, the haptic device 112 may be operatively coupled to the processing unit 102 and memory 104. In some embodiments, the haptic device 112 may be directly controlled by the processing unit 102. In some embodiments, the haptic device 112 may be controlled, at least in part, by the operation of an input component 106, including, for example, a button, dial, crown, or the like. The operation of the haptic device 112 may also be paired or linked to the operation of one or more other output devices, including, for example, the display 120 or the speaker 122.

As shown in FIG. 2, the device 100 may include a battery 114 that is used to store and provide power to the other components of the device 100. The battery 114 may be a rechargeable power supply that is configured to provide power to the device 100 while it is being worn by the user. The device 100 may also be configured to recharge the battery 114 using a wireless charging system. Accordingly, in some cases, the device may include a wireless power module 116 that may be configured to receive power from an external device or dock. The wireless power module 116 may be configured to deliver power to components of the device, including the battery 114. The wireless power module 116 and an external charging station or dock may also be configured to transmit data between the device and a base or host device. In some cases, the wireless power module 116 may interface with the wireless charging station or dock to provide an authentication routine that is able to identify specific hardware, firmware, or software on the device in order to facilitate device maintenance or product updates. A more detailed description of an example wireless charging station is provided below with respect to FIGS. 18-19.

The device 100 may include a variety of other components, including for example, a camera or camera modules. The camera may be configured to capture an image of a scene or subject located within a field of view of the camera. The image may be stored in a digital file in accordance with any one of a number of digital formats. In some embodiments, the device 100 includes a camera, which includes an image sensor formed from a charge-coupled device (CCD) and/or a complementary metal-oxide-semiconductor (CMOS) device. The camera may also include one or more optical components disposed relative to the image sensor, including, for example, a lens, a filter, a shutter, and so on.

FIG. 3 depicts functional elements of the device 100, in accordance with some embodiments. In particular, FIG. 3 depicts the inputs that may be received and outputs that may be produced on an example device 100. By way of example, the device 100 may correspond to the devices shown in

16

FIGS. 1 and 2. As shown in FIG. 3, the device 100 may include a force input 302 that may be produced using a force sensor that is configured to detect and measure the magnitude of a force of a touch on a surface of the device. The force input 302 may include a non-binary output that is generated in response to a touch. For example, the force input 302 may include a range of values or analog value that corresponds to the amount of force exerted on a surface of the device. Additionally or alternatively, the force input 302 may include binary (e.g., on, off) output in response to the force of a touch. The force input 302 may be used to control various aspects of the device. For example, the force input 302 may be used to control an aspect, such as a cursor or item selection on a user interface presented on the display of the device. The force input 302 may also be used to control the audio output 308, haptic output 312, and other functionality of the device. The force input 302 may also be used to distinguish between different types of input from the user. For example, a light touch from the user may be interpreted as a scroll command and used to index or scroll through a list of items on the display. A harder touch from the user may be interpreted as a selection or confirmation of an item on the display. In some embodiments, the force input 302 is used to distinguish an intentional touch from the user from an incidental or accidental touch that may be ignored.

As shown in FIG. 3, the device 100 may also include a touch input 306 that may be produced using a touch sensor that is configured to detect and measure the location of a touch on a surface of the device. In some implementations, the touch sensor is a capacitive-based touch sensor that is disposed relative to the display or display stack of the device. The touch sensor may be a separate non-integrated sensor relative to the force sensor. In alternative embodiments, the touch sensor may also be physically and/or logically integrated with the force sensor to produce a combined output. The touch input 306 may be used to control various aspects of the device. For example, the touch input 306 may be used to control an aspect of the user interface presented on the display of the device. The touch input 306 may also be used to control the audio output 308, haptic output 312, and other functionality of the device.

In some cases, the logical integration of the force input 302 and the touch input 306 enhances the versatility or adaptability of device 100 by enabling a more sophisticated user interface than is currently available on some traditional wearable devices. In particular, the force input 302 and the touch input 306 may be combined to interpret a wider range of gestures and input commands than may be possible using, for example, only a touch input. For example, the force input 302 may provide a magnitude of a force of a touch, which may be used to distinguish between two touch input commands that have a similar location or gesture path. An improved touch interface using both force input 302 and touch input 306 may be particularly advantageous when interpreting touch commands on a relatively small area surface, such as a display screen or cover glass of a wearable electronic device.

As shown in FIG. 3, the device 100 may also include a button/dial input 310 that may be produced using an input device that is configured to receive input from the user. As described previously, the device 100 may include one or more buttons disposed on or near an external surface of the housing and are configured to receive input from a user. The device may also include a dial or crown that is configured to accept rotational input from the user. As described in more

US 11,474,483 B2

17

detail below with respect to FIGS. 24A-B, the dial or crown may also include a push feature that is adapted to accept input from the user.

The device 100 may also accept audio input 314 using a microphone or other acoustic sensing device. The audio input 314 may be adapted to accept input from the user, including voice commands and other audio signal input. The audio input 314 may also be adapted to detect and measure ambient audio conditions that may be used to adjust the volume of the audio output 308 or operation of the haptic output 312. The audio input 314 may also be used to record an audio stream or voice message in accordance with an audio recording application or software program.

As shown in FIG. 3, the device 100 may include a display output 304 in accordance with some embodiments. The display output 304 includes visual or graphical output that may be produced using the display element of the device. In some embodiments, the display output 304 includes a graphical user interface produced using an operating system or software application executed on one or more processing units of the device. In one example, the display output 304 includes a graphical depiction that resembles a watch face or other timekeeping device. In other examples, the display output 304 includes a graphical interface for an e-mail, text messaging, or other communication-oriented program. The display output 304 may also present visual information that corresponds to one of the other functional aspects of the device 100. For example, the display output 304 may include information that corresponds to the biosensor input 320, sensor input 318, force input 302, touch input 306, and others.

As shown in FIG. 3 the device 100 may include an audio output 308 that may be produced with a speaker or acoustic module. The audio output 308 may include sounds or audio signals that are associated with the operation of the device. For example, the audio output 308 may correspond to the operation of an input device to provide audio feedback to the user. For example the audio output 308 may correspond to an input received in the form of a force input 302, touch input 306, and/or button/dial input 310. In some cases, the audio output 308 may also include a portion of an auditory alert that may be produced alone or combined with a haptic output 312 and/or display output 304 of the device 100.

The device 100 may also include a sensor input 318 produced using one or more sensors that may be configured to monitor and detect various environmental conditions. For example, the sensor input 318 may include signals or data produced using an ambient light sensor, proximity sensor, temperature sensor, barometric pressure sensor, or other sensor for monitoring environmental conditions surrounding or near the device. In general, the sensor input 318 may be used to adapt the functionality of the device 100 to conform to the one or more environmental conditions. For example, the brightness of the display output 304, the volume of the audio output 308, and/or the operation of the input to the device 100 may be based on the sensor input 318.

In some embodiments, the sensor input 318 includes input produced by one or more motion sensors. The motion sensors may include one or more of the following: an accelerometer, a gyroscope, a tilt sensor, or other type of inertial measurement device. A sensor input 318 produced using one or more motion sensors may be used to monitor and detect changes in motion of the device 100. Changes in linear and angular motion may be used to determine or estimate an orientation of the device relative to a known location or fixed datum. The sensor input 318 produced from the one or more motion sensors may also be used to track the

18

movement of the user. The movement of the user may be used to facilitate navigation or map-guided functionality of the device. Additionally, input related to the gross movement of the user can be used as a pedometer or activity meter, which may be stored and tracked over time to determine health metrics or other health-related information. Additionally, in some embodiments, sensor input 318 from the one or more motion sensors may be used to identify motion gestures. For example, the motion sensors can be used to detect an arm raise or the position of a user's body (within a predetermined confidence level of certainty).

The device 100 may also include a biosensor input 320 produced using one or more biosensors or biosensor modules that are configured to monitor physiological and/or health conditions of a user. As discussed above with respect to FIG. 2, the device may include one or more optical sensors for measuring heart rate, blood pressure, oxygen saturation, or a combination thereof. The device may also include one or more sensors having electrical contacts that are disposed to contact the user's body. The sensors may be configured to measure electrocardiographic (ECG) characteristics, galvanic skin resistance, and other electrical properties of the user's body. Additionally or alternatively, sensors may be configured to measure body temperature, exposure to UV radiation, and other health related information. The biosensor input 320 may be combined with other aspects of the device to provide health-monitoring functionality. For example, the biosensor input 320 may be used to compute data that is presented using the display output 304. The operation of the biosensor input 320 may also be controlled using the force input 302, touch input 306, or other user input 310 to provide an interactive health monitoring function or application.

As shown in FIG. 3, the device may include a haptic output 312 that may be produced using one or more haptic devices that are configured to provide haptic feedback to the user. In particular, the haptic output 312 may be produced using one or more electromechanical subassemblies that are configured to induce motion or vibration in the device, which may be perceived or sensed by the user. In some cases, the haptic actuator or device is tuned to operate based on a resonance or near resonance with respect to the device, which may enhance haptic output. In some cases, the haptic actuator or device is configured to operate based on a resonance or near resonance with respect to some components of the device, such as the band or clasp of the device.

In some embodiments, the haptic output 312 may correspond to the operation of one or more other modules or subsystems. For example, the haptic output 312 may include a vibration or haptic feedback that corresponds to an audio alert or visual alert or signal produced by the acoustic module or display, respectively. Additionally or alternatively, the haptic output 312 may be operated in conjunction with an input from the user. The haptic output 312 may include haptic or force feedback that confirms that the user input was or is being received. By way of example, a haptic output 312 may include a click or vibration when the crown of the device is turned or a button is depressed. The haptic output 312 may also be coordinated with other functionality of the device including, for example, message transmission operations, power management operations, force sensor operations, biosensor operations, to provide a notification, to provide an alert, and others.

As shown in FIG. 3, the device 100 may also include communications input/output (I/O) 316, which may facilitate communication with an external device or system. The communications I/O 316 may be produced using one or

## US 11,474,483 B2

19

more wireless interfaces, including radio frequency cellular interfaces, fiber optic interfaces, acoustic interfaces, Bluetooth interfaces, Near Field Communication interfaces, infrared interfaces, USB interfaces, Wi-Fi interfaces, TCP/IP interfaces, network communications interfaces, or any conventional communication interfaces. In some cases, the communications I/O 316 may include signals and data received from an external device that has been paired or is otherwise in electronic communication with the device 100. The external data included in the communications I/O 316 may include, for example, message data associated with an electronic communication, notification data associated with an event, and/or data related to audio or visual content. The communications I/O 316 may also include an authorization or identification of external devices in communication with the device 100 or users associated with one or more external devices. Similarly, the communications I/O 316 may be used to output various forms of data or signals to one or more devices or systems that are external to the device 100. For example, the communications I/O 316 may include data or computations that are produced using the biosensor input 320 and/or the sensor input 318.

FIG. 4 depicts an example wearable electronic device 100 as part of a system of devices. By way of example, the wearable electronic device 100 of FIG. 4 may correspond to the devices shown in any of the previous figures. Generally, the wearable electronic device 100 may communicate wirelessly with any of a number of other devices, such as mobile phone 420, computer 430, tablet computing devices, personal media players, televisions, networked home appliances, networked home controls, electronic systems in vehicles, and so on. Additionally, the wearable electronic device 100 may communicate wirelessly with any of a number of electronic accessories, including headset devices, portable speaker devices, portable microphone devices, display screens, and so on. Communication may be through a wired or wireless connection, including any technology mentioned herein.

In some embodiments the wearable electronic device 100 may accept a variety of bands, straps, or other retention mechanisms (collectively, "bands"). These bands may be removably connected to the electronic device by a feature formed into the band or band assembly that is accepted in a recess or other aperture within the device and locks thereto. An example band interface is described in more detail below with respect to FIGS. 25A-C.

In general, a user may change combinations of bands and electronic devices, thereby permitting mixing and matching of the two categories. It should be appreciated that devices having other forms and/or functions may include similar recesses and may releasably mate with a lug and/or band incorporating a lug. In this fashion, a system of bands and devices may be envisioned, each of which is compatible with another. A single band may be used to connect to devices, as one further example; in such embodiments the band may include electrical interconnections that permit the two devices to transmit signals to one another and thereby interact with one another.

Insofar as the electronic device 100 may connect either physically or through a data communication link with other computing devices, the combination of devices and bands may be thought of as an ecosystem having multiple parts that interact with one another, may intelligently communicate with one another, may share functionality and/or may substitute for one another in terms of operations, output, input and the like. Examples of devices existing in such an ecosystem follow, but are illustrative rather than limiting.

20

As one example, a number of electronic devices 100, 420, 430 may each have identical or similar attachment structures that permit them to share a band or connector. A user may thus change the interconnected band and device(s) with respect to one another, permitting a number of different physical connections between different ecosystem components. In some embodiments, a band that serves to retain an electronic device only may be swapped for bands having additional functionalities, such as transmitting data between devices connected to the band, adding functionality to a connected device that the device lacks, providing additional power to a connected device, and so on. Further, different bands may look different, so that the appearance of the electronic device(s) in combination with a band(s) may change by changing the band(s) and/or device(s) with respect to one another.

As another example, electronic devices 100, 420, 430 may communicate with one another as part of the overall ecosystem. Data may be passed from one device 420 to another 100. This may be useful if the user 410 is wearing one electronic device 100 but is not near another device 430 that wishes to notify the user or interact with the user in some fashion. Continuing the example, the computer 430 may transmit a reminder or message to the wearable device 100 to gain the user's attention. As another example, the computer 430 (or any other electronic device in the ecosystem) may transmit a state of an application or even the device itself to the wearable device 100. Thus, for example, if an application operating on the computer needs the user's attention, it may be gained through an alert issued by the wearable device.

Data communication between devices in an ecosystem may also permit the devices to share functionality. As one non-limiting example, electronic devices may share sensor data with one another to permit one device access to data it normally would not have, from a sensor it does not physically incorporate. Thus, any given device 100, 420, 430 may draw on the abilities of other devices in the ecosystem to provide an enhanced and relatively seamless experience for a user 410.

FIG. 5 depicts a system 500 of interchangeable components for a wearable device. By way of example, one or more of the devices of FIG. 5 may correspond to the devices shown in any of the previous figures. FIG. 5 depicts a system 500 including a variety of interchangeable components, including multiple device bodies 515, 525, 535 that are configured to connect via a standard interface to any one of a number of different bands 551a-b, 552a-b, 553a-b, 554a-b, and 555a-b. In addition, each of the three devices may be configured to connect via a standard interface to another type of non-band component, such as a lug 556a-b, non-band component, or other device.

As shown in FIG. 5, the system 500 may include a body or device that is adapted to attach to one or more bands, straps, or other similar component that may be used to attach the device to the body of a user. In some embodiments, the device may be interchangeable or interchangeable to provide a different set of functions or features. In some embodiments, the bands or attachment components may be interchangeable or interchanged to provide desired functionality or features.

In the example depicted in FIG. 5, each of the devices includes at least one receiving feature 504 that is configured to interconnect with a corresponding feature 502 that is attached to or integrally formed with the end of each of the bands or other mating parts. In some embodiments, receiving feature 504 includes a channel or groove that is formed in one end of the device body. The mating feature 502 of a



respective band or component may be configured to slidably engage with the receiving feature 504 of a respective device body to attach the band or component. An example receiving feature is described in more detail below with respect to FIGS. 25A-C. In some embodiments, the receiving feature 504 and the mating feature 502 are standardized in the system 500 and, thus, any of the bands (551a-b, 552a-b, 553a-b, 554a-b, and 555a-b) can be interchangeably used with any of the device bodies 515, 525, 535.

With respect to FIG. 5, each of the bands may be formed from a different material or using a different construction. In the present example, bands 551a-b may be formed from a textile material that may be constructed from a pattern of thread or fiber material. The textile material may include a variety of materials, including natural fibers, synthetic fibers, metallic fibers, and so on. The bands 552a-b may be formed from a woven material and may be constructed from an array of warp fibers or threads interwoven with one or more weft fibers or threads. Similarly, the warp and weft fibers may include a variety of materials, including natural fibers, synthetic fibers, metallic fibers, and so on. The bands 553a-b may be formed from leather material 553a-b. In one example, the bands 553a-b are formed from a sheet or strip of cowhide; however, the bands 553a-b may also be formed from one of any number of types of animal hide. The leather material 553a-b may also include a synthetic leather material, such as vinyl or plastic. The bands 554a-b may be formed from a metallic mesh or link construction. For example the bands 554a-b may be formed from a Milanese mesh or other similar type of construction. The bands 555a-b may be formed from a silicone or other elastomer material.

In some cases, the band is a composite construction including various materials, which may be selected based on the end use or application. In some embodiments, a first band strap, or a first portion of the first band strap, may be made up of a first material and a second band strap, or a second portion of the second band strap, may be made from a second, different material. The band may also be made up of a plurality of links and, as such, the band may be resizable by, for example, adding or removing links. Example bands and band constructions are provided below in Section 12.

In the system 500, an interchangeable band may allow for individual customization of the device or to better adapt the device for a range of uses or applications. In some instances, the type of band that is selected and installed can facilitate a particular user activity. For example, band 551a-b may be formed from a textile material and include a durable clasp that may be particularly well suited for exercise or outdoor activities. Alternatively, as discussed above the band 554a-b may be formed from a metallic material and include a thin or low-profile clasp that may be well suited for more formal or fashion-focused activities.

In some embodiments, the band may be coupled to a separate component having the mating feature 502. The band may be coupled using pins, holes, adhesives, screws, and so on. In yet other embodiments, the band may be co-molded or overmolded with at least a portion of the component having the mating feature 502. In some embodiments, the band is coupled to the component via a pin that allows the straps to rotate with respect to the component. The pin may be formed integrally with or disposed in a loop formed in the end of the band.

In the example system 500, each of the bands is shown as having a generic band clasp. However, the type of band clasp that is used may vary between embodiments. One example band clasp may include a first band strap having a buckle or

tang assembly which is configured to interface with a second band strap having a series of apertures or holes formed with the strap. Additionally or alternatively, the bands may include a magnetic clasp having one or more magnetic elements on a first band strap that is configured to mate to one or more magnetic or ferromagnetic elements on a second band strap.

As shown in FIG. 5, the system may include multiple device bodies 515, 525, 535 that may vary in size, shape, and composition. The device body 515, 525, 535 may include one or more of the embodiments described herein and may include, but is not limited to a wearable computer, a wearable watch, a wearable communication device, a wearable media player, a wearable health monitoring device, and/or the like. In particular, the device body may correspond to the device body described with respect to device body 610 of device 100 (shown in FIG. 6).

### 1. Example Wearable Electronic Device

FIG. 6 depicts an example wearable electronic device, which may include various aspects of the device(s) described above. In some embodiments, multiple modules or subsystems are physically and operationally integrated together to provide particular functionality or device features. In particular, the interaction between the subsystems, or the subsystems themselves, may be configurable by the user, manufacturer, or vendor to adapt the device to produce certain functionality. Some example combinations and interactions between the various modules and subsystems are expressly provided in the present description. However, the combinations and interactions provided herein are merely illustrative in nature and are not intended to be limiting on the scope of the disclosure.

FIG. 6 depicts an example configuration of a wearable electronic device 100. In particular, FIG. 6 depicts an electronic wearable device 100 including a device body 610 that may be configured to be attached to the wrist of a user using a band assembly 620. This configuration may also be referred to herein as a wearable device, a device, an electronic wristwatch, or an electronic watch. While these terms may be used with respect to certain embodiments, the functionality provided by the example electronic wearable device 100 may be substantially greater than or vary with respect to many traditional electronic watches or timekeeping devices.

In the present example, the exterior surface of the device body 610 is defined, in part, by the exterior surface of the housing 601 and the exterior surface of the cover 609. In the example depicted in FIG. 6, the device body 610 is substantially rectangular with round or curved side portions. The outer surfaces of the cover 609 and the housing 601 coincide at a joint interface and cooperate to form a continuous contoured surface. The continuous contoured surface may have a constant radius and may be tangent to a flat middle portion of the cover 609 and/or a flat bottom portion of the housing 601. In some embodiments, the cover 609 has substantially the same shape as a flat bottom portion and at least a portion of the curved side portions of the housing 601. A more complete description of the geometry of the cover 609 and the housing 601 is provided below with respect to FIGS. 7 and 8.

In the example of FIG. 6, the device 100 includes a display (item 120 of FIG. 2) that is disposed at least partially within an opening or cavity defined within a top portion of the housing 601 of the device body 610. The display may be formed from a liquid crystal display (LCD), organic light

US 11,474,483 B2

23

emitting diode (OLED) display, organic electroluminescence (OEL) display, or other type of display device. The display may be used to present visual information to the user and may be operated in accordance with one or more display modes or the software applications being executed on the device 100. By way of example, the display may be configured to present the current time and date similar to a traditional watch or timepiece. The display may also present a variety of other visual information that may correspond to or be produced using one of the other modules in the device 100. For example, the display may be configured to display one of a variety of notification messages, which may be generated based on data received from the one or more sensors, the wireless communication system, or other subsystem of the device 100. The display may also be configured to present visual information or data that is based on the output of one or more sensor outputs. The display may also provide status or information related to a wireless charging process or battery power. The display may also present visual output or information related to media being produced using a speaker or acoustic module of the device 100. Accordingly, a variety of other types of visual output or information may be presented using the display.

In the current example, the display includes or is integrated with a cover 609 that helps to protect the display from physical impact or scratches. In the field of wearable devices, the cover 609 may also be referred to generically as a crystal or cover glass, regardless of the material that is used to form the cover 609. In some cases, the cover 609 is formed from a sheet or block of sapphire material. Sapphire may provide superior optical and surface hardness properties as compared to other materials. In some cases, the sapphire material has a hardness of approximately 9 on the Mohs scale. In alternative embodiments, the cover 609 is formed from a glass, polycarbonate, or other optically transparent material. The cover 609 may also be coated with one or more optical or mechanical enhancing materials or surface treatments. For example, interior and/or exterior surfaces of the cover 609 may be coated with an anti-reflective (AR), oleophobic or other coating to enhance the visible or functional properties of the display. Additionally, in some cases, the cover 609 may be configured to cooperate with an antenna used to facilitate wireless communication with an external device. FIGS. 21A-B, described in more detail below, provide one example embodiment of a cover configured to cooperate with an antenna.

In the example depicted in FIG. 6, the cover 609 is formed from a transparent material and, when assembled has an external surface and an internal surface. The cover 609 is disposed above the display and encloses a cavity or opening formed in the top portion of the housing 601. In some embodiments, the external surface of the cover 609 cooperates with the external surface of the housing to form a substantially continuous external peripheral surface of the electronic device. As shown in FIG. 6, the external surface of the cover 609 has a flat middle portion at the center of the cover, which extends outwardly. The cover 609 also includes a curved edge portion that emanates from and surrounds the flat middle portion and extends outwardly to an edge at the side of the cover 609. In some embodiments, the cover 609 also includes an opaque mask disposed relative to the internal surface of the transparent cover. The opaque mask may correspond to or otherwise define the viewable area of the display 120. The mask may have an outer boundary that is located proximate the edge of the side of the cover 609 and has an inner boundary located within the curved edge portion of the cover 609.

24

As shown in FIG. 6, the cover 609 is disposed relative to a top portion of the housing 601. The housing 601 includes a top portion defining an opening, which is surrounded by a curved side portion. In the present example, the curved edge portion of the cover 609 coincides with the curved side portion of the housing 601 to form a continuous external surface of the electronic device 100. In some instances, the cover 609 may have a contour that follows or otherwise corresponds to a similar contour of the housing 601 to form a substantially continuous surface at the interface between the two components. As shown in FIG. 6, the cover 609 protrudes above the housing 601.

In some instances, the cover 609 is disposed relative to a touch sensor (item 702 of FIG. 7). In some embodiments, the touch sensor may be integrated with the display or other element of the device 100. The touch sensor may be formed from one or more capacitive sensor electrodes or nodes that are configured to detect the presence and/or location of an object or the user's finger that is touching or nearly touching the surface of the display. In some cases, the touch sensor includes an array of sensing nodes formed in accordance with a mutual capacitance sensing scheme.

In one example, the touch sensor may include an array of mutual capacitance touch nodes that can be formed by a two-layer electrode structure separated by a dielectric material. One layer of electrodes may comprise a plurality of drive lines and another layer of electrodes may comprise a plurality of sense lines, and where the drive lines and the sense lines cross, mutual capacitive sense nodes are formed (also referred to as coupling capacitance). In some implementations, the drive lines and sense lines may cross over each other in different planes separated from one another by a dielectric. Alternatively, in other embodiments the drive lines and sense lines can be formed substantially on a single layer. An example touch sensor and touch-sensing node are described in more detail below with respect to FIGS. 14A-C and 15A-B.

Alternatively or additionally, the touch sensor may include one or more self-capacitive nodes or electrodes that are configured to detect a discharge of electrical current or charge when an object, such as a user's finger, contacts or nearly contacts a surface of the housing 601 or other surface of the device 100. Other types of electronically sensing nodes, including resistive, inductive, or the like, may also be integrated into a surface of the device 100.

In some embodiments, the device 100 may also include a force sensor (item 705 of FIG. 7). The force sensor may be disposed relative to the display 120 or integrated with other elements of the device 100. In some cases, the force sensor includes one or more force sensing structures or force-sensing nodes for detecting and measuring the magnitude of a force or pressure due to a touch on a surface of the device 100. The force sensor may be formed from or implement one or more types of sensor configurations. For example, capacitive and/or strain based sensor configurations may be used alone or in combination to detect and measure the magnitude of a force or pressure due to a touch. As described in more detail below, a capacitive force sensor may be configured to detect the magnitude of a touch based on the displacement of a surface or element on the device. Additionally or alternatively, a strain-based force sensor may be configured to detect the magnitude of a touch based on the deflection. Example force sensor and force-sensing modules are described in more detail below with respect to FIGS. 9-12.

As shown in FIG. 6, the device 100 also includes device body 610 including a housing 601 that upon which may be mounted or integrated with various components of the

US 11,474,483 B2

25

device **100**. The housing **601** serves to surround at a peripheral region as well as support the internal components of the product in their assembled position. In some embodiments, the housing **601** may enclose and support internally various components (including for example integrated circuit chips and other circuitry) to provide computing and functional operations for the device **100**. The housing **601** may also help define the shape or form of the device. That is, the contour of the housing **601** may embody the outward physical appearance of the device. As such, it may include various ornamental and mechanical features that improve the aesthetical appearance and tactile feel of the device. For example, the housing **601** may include a contoured surface that includes rectilinear contours, curvilinear contours, or combinations thereof. The housing **601** may also include various surface features, including textures, patterns, decorative elements, and so on.

In the present example, the housing **601** is formed from a single piece, which may also be referred to as single-body, unitary, or uni-body design or construction. By utilizing a single-body construction, the structural integrity of the device may be improved as compared to a multi-piece construction. For example, a single body may be more easily sealed from contaminants as compared to a multi-piece enclosure. Additionally, a single-body enclosure may be more rigid due, in part, to the absence of joints or seams. The rigidity of the housing **601** may be further enhanced by increasing the material thickness in areas where mechanical stress may be greatest, while also maintaining or thinning other areas where mechanical stress may be lower or reduced. Variations in the thickness of the housing **601** may be possible by machining or casting the housing **601** as a single piece. Additionally, a single-body housing **601** may include one or more features for mounting or integrating the internal components of the device **100**, which may facilitate manufacturing and/or assembly of the device **100**.

An example housing **601** is described in more detail below with respect to FIG. **8**. The housing **601** may be formed from a variety of materials, including, without limitation plastic, glass, ceramics, fiber composites, metal (e.g., stainless steel, aluminum, magnesium), other suitable materials, or a combination of these materials. Further, the housing **601** may include a surface treatment or coating, which may be formed from a variety of materials, including, without limitation aluminum, steel, gold, silver and other metals, metal alloys, ceramics, wood, plastics, glasses, and the like.

As discussed above, the display, the touch sensor, and force sensor may be disposed within the housing **601**. In this example, one or more buttons **644** and a crown **642** used to receive user input may also be disposed within or relative to the housing **601**. Other types of user input, including for example, one or more dials, slides, or similar user input devices or mechanisms may also be disposed within or relative to the housing **601**. As described in more detail with respect to FIGS. **7** and **8**, the housing **601** may include various features for attaching and mounting the subassemblies and modules of the device **100**. In particular, the housing **601** may have one or more openings for receiving the cover **609**, the display, the force sensor, or other components. The housing **601** may also include one or more holes or openings for receiving the button **644** and crown **642** that are located around the perimeter of the device **100**. In some embodiments, the housing **601** also includes internal features, such as bosses and threaded portions, that can be used to attach modules or components within the housing **601**.

26

The device **100** may also include an ambient light sensor (ALS) that is configured to detect and measure changes in ambient lighting conditions. The ALS may include a photodiode and one or more optical elements or lenses for collecting light. An ALS may be located on an external facing surface that is less likely to be blocked when the device is worn or in use. The ALS may be used to adjust settings, including screen brightness and other visual output depending on the overall lighting conditions.

The housing **601** may also include one or more motion-sensing elements or devices for detecting motion of the device **100**. For example, the device **100** may include one or more accelerometers that are configured to sense acceleration or changes in motion. Additionally or alternatively, the device **100** may include one or more gyroscopic sensors that are configured to detect changes in direction. In some cases, the one or more gyroscopic sensors may include a spinning mass that can be used to detect changes in angular velocity. Multiple motion-sensing elements may be used to detect motion along multiple directions or axes. The motion sensors may also be used to identify motion gestures. For example, the motion sensors can be used to detect an arm raise or the position of a user's body (within a predetermined confidence level of certainty). The one or more motion-sensing elements may be used to determine an orientation of the device relative to a known or fixed datum. For example, the device may include a compass and/or global positioning system (GPS) that can be used to identify an absolute position. The one or more motion sensing elements may then measure deviation or movement with respect to the absolute position to track movement of the device or the user wearing the device. In some implementations, the one or more motion-sensing elements are used to detect gross movement of the device or user. The gross movement may be used as a pedometer or activity meter, which may be tracked over time and used to calculate a health metric or other health-related information.

Described in more detail with respect to FIG. **8**, the housing **601** may also include one or more openings or orifices coupled to an acoustic module or speaker **122**, which may include a speaker and/or a microphone subassembly. Although the housing **601** may include one or more openings or orifices, the housing **601** may still be substantially waterproof/water resistant and may be substantially impermeable to liquids. For example, the opening or orifice in the housing or enclosure may include a membrane or mesh that is substantially impermeable to liquid ingress. Additionally or alternatively, the geometry of the opening or orifice and other internal features of the housing **601** may be configured to reduce or impede the ingress of liquid or moisture into the device **100**. In one example, the opening is formed from one or more orifices that are offset with respect to an internal acoustic chamber or cavity, which may prevent a direct path from the outside of the housing **601** into the acoustic module.

As shown in FIG. **6**, the device **100** includes a device body **610** that may be attached to a user's wrist using a band **620**. In the present example, the band **620** include a first band strap **621** attached to a first receiving feature **623** and a second band strap **622** attached to a second receiving feature **624**. In some embodiments, the first and second band straps **621**, **622** include a lug feature that is configured to attach to the first and second receiving features **623**, **624**, respectively. As shown in FIG. **6**, the free ends of the band straps **621**, **622** are connected with a clasp **625**.

The band straps **621**, **622** are formed from a flexible or compliant material that may be specially configured for a



US 11,474,483 B2

27

particular application. The band straps **621**, **622** may be formed from a variety of materials, including, for example, leather, woven textiles, or metallic mesh materials. The material and construction of the band straps **621**, **622** may depend on the application. For example, the band straps **621**, **622** may be formed from a woven textile material configured for exposure to impact and moisture typically associated with outdoor activities. In another example, the band straps **621**, **622** may be formed from a metallic mesh material that may be configured to have a fine finish and construction that may be more appropriate for professional or social activities.

Similarly, the clasp **625** of the band **620** may be configured for a particular application or to work with a particular style of band. For example, if the band straps **621**, **622** are formed from a metallic mesh material, the clasp **625** may include a magnetic clasp mechanism. In the present example, the device **100** is configured to be attached to the wrist of a user. However, in alternative embodiments, the device may be configured to be attached to the arm, leg or other body part of the user.

The housing **601** includes one or more features for attaching the band straps **621**, **622**. In the present example, the housing **601** includes a first receiving feature **623** and a second receiving feature **624** for attaching the first band strap **621** and the second band strap **622**, respectively. In this example, the band straps **621**, **622** include a lug portion that is adapted to mechanically engage with the receiving features **623**, **624**. A more detailed description of the receiving features and lugs is provided below with respect to FIGS. 25A-C. As shown in FIG. 6, the first **623** and second receiving features **624** may be integrally formed into the housing **601**. In alternative embodiments, the receiving features may be formed from separate parts and may be attached to the housing **601** during manufacturing. In some embodiments, the receiving features **623**, **624** may be configured to release the band straps **621**, **622** from the device body **610** (e.g., the housing **601**). For example, one or both of the receiving features **623**, **624** may include a button or slide, which may be actuated by the user to release a corresponding band strap **621** and **622**. One advantage of a releasable lug is that the user can swap between a variety of bands that may be specially configured for a particular use scenario. For example, some bands may be specially configured for sport or athletic activities and other bands may be configured for more formal or professional activities.

The device **100** may also include a rear cover **608** located on the rear-facing surface of the housing **601** of the device body **610**. The rear cover **608** may improve the strength and/or scratch resistance of the surface of the device **100**. For example, in some embodiments, the rear cover **608** may be formed from a sapphire sheet, zirconia, or alumina material having superior scratch resistance and surface finish qualities. In some cases, the sapphire material has a hardness greater than 6 on the Mohs scale. In some cases, the sapphire material has a hardness of approximately 9 on the Mohs scale. Due to the superior strength of the sapphire material, a cover glass formed from a sapphire sheet may be very thin. For example, the thickness of a sapphire cover sheet may be less than 300 microns thick. In some cases, the thickness of a sapphire cover sheet may be less than 100 microns thick. In some cases, the thickness of a sapphire cover sheet may be less than 50 microns thick. In some embodiments, the rear cover **608** is contoured in shape. For example, the rear cover **608** may have a convex curved surface.

FIG. 7 depicts an example exploded view of various modules and subassemblies of the device **100**. As shown in FIG. 7, multiple components are configured to be disposed

28

within and/or attached to the housing **601**. The exploded view provided in FIG. 7 depicts one example arrangement of the components of the device **100**. However, in other embodiments, arrangement, placement, and/or grouping of the subassemblies and the components of the subassemblies may vary.

In the present example, a main cavity of the housing **601** houses an electronics subassembly **720** and the battery **114** of the device. The electronics subassembly **720** includes one or more electrical circuit assemblies for coupling the various electrical components of the device **100** to each other and to power supplied by the battery **114**. The electronics subassembly **720** may also include structural elements or components that provide structural rigidity for the electronics subassembly **720** and/or structural mounting or support for other components disposed within the housing **601**. As shown in FIG. 7, within the cavity of the housing **601**, the speaker **122**, the crown module **642**, and the battery **114** are all disposed above the electronics subassembly **720**. In the present embodiment the top surface of the speaker **122**, the crown module **642**, and the battery **114** have a substantially similar height. In some embodiments, the speaker **122**, the crown module **642**, and the battery **114**, when assembled in the housing **601**, define an area for the display **120** within the cavity. Thus, as shown in FIG. 7, the display **120** may overlay the speaker **122**, the crown module **642**, and the battery **114**, which overlay the electronics subassembly **720**.

As shown in FIG. 7, the cover **609** is configured to fit within a corresponding recess formed within the housing **601**. In particular, the cover **609** includes a vertical portion having a height that corresponds to the depth of the recess formed within the housing **601**. In this example, the device **100** includes a force sensor **705** disposed between the housing **601** and a cover subassembly **704**. As described in more detail below with respect to FIGS. 9 and 10A-B, the force sensor **705** may be configured to detect a force placed on a surface of the cover **609** by detecting a relative deflection between the cover **609** (or cover subassembly **704**) and the housing **601**. In the present example, the force sensor **705** also forms a gasket or seal between the cover subassembly **704** and the housing **601**. In some implementations, the seal is a water-proof or water-resistant seal that helps to prevent water or liquid ingress into the internal cavity of the housing **601**. The force sensor **705** may also be used to join the cover subassembly **704** to the housing **601** using an adhesive or film.

In some embodiments, the cover subassembly **704** includes the cover **609** which is disposed above the touch sensor **702** and display **120**. In the present example, the touch sensor **702** and the display **120** are attached to each other by an optically clear adhesive layer (OCA). Similarly, an OCA layer is used to attach the touch sensor **702** to the cover **609**. Other adhesives or bonding techniques may be used to attach the display **120** and the touch sensor **702** to the cover **609**. In some embodiments, the touch sensor **702** is integrated into the display **120** and the display **120** (and integrated touch sensor **702**) are attached to the cover **609**.

As shown in FIG. 7, the speaker **122** is also disposed within the cavity of the housing **601**. The speaker **122** is adapted to mechanically and acoustically interface with a port formed in the side of the housing **601**. In some embodiments, the port is configured to prevent a direct path for water or liquid into an acoustic chamber or cavity of the speaker **122**. In some embodiments, the device **100** also includes a microphone that is similarly coupled to another port formed in the side of the housing **601**. A more detailed

description of the speaker 122 and microphone is provided below with respect to the acoustic module of FIG. 20.

In the present example, the haptic device 112 is also disposed within the cavity of the housing 601 proximate to the speaker 122. In some embodiments, the haptic device 112 is rigidly mounted to a portion of the housing 601. A rigid mounting between the housing 601 and the haptic device 112 may facilitate the transmission of vibrations or other energy produced by the haptic device 112 to the user. In the present example, the haptic device 112 includes a moving mass that is configured to oscillate or translate in a direction that is substantially parallel with a rear face of the housing 601. In some implementations, this orientation facilitates the perception of a haptic output produced by the haptic device 112 by a user wearing the device 100. While this configuration is provided as one example, in other implementations, the haptic device 112 may be placed in a different orientation or may be configured to produce a haptic response using a rotating mass or other type of moving mass.

As shown in FIG. 7, the device also includes an antenna subassembly 722. In this example, a portion of the antenna subassembly 722 is disposed within the housing 601 and a portion of the antenna subassembly 722 is disposed within the cover assembly. In some implementations, a portion of the antenna subassembly 722 is disposed relative to a feature formed within the cover 609. An example embodiment is described in more detail below with respect to FIGS. 21A-B.

In the example depicted in FIG. 7, the device 100 also includes a crown module 642 which is disposed in an aperture or hole in the housing 601. When installed, a portion of the crown module 642 is located outside of the housing 601 and a portion of the crown module 642 is disposed within the housing 601. The crown module 642 may be configured to mechanically and/or electrically cooperate with the electronics subassembly 720. A more detailed description of an example crown module is provided below with respect to FIGS. 23 and 24A-B. The housing 601 also includes a button 644, which is disposed in an opening of the housing 601 and may be configured to mechanically and/or electrically cooperate with the electronics subassembly 720.

In the example depicted in FIG. 7, a biosensor module 710 is disposed in an opening formed in the rear surface of the housing 601. In some embodiments, the biosensor module 710 includes the rear cover 608 and may also include a chassis or plate that facilitates attachment of the biosensor module 710 to the housing 601. The chassis or plate or the cover sheet 608 may also include features or elements that facilitate a watertight seal between the biosensor module 710 and the housing 601. For example, the rear cover 608 may include a shelf or flange that may be used to form a seal between the biosensor module 710 and the housing 601. As described in more detail below with respect to FIG. 16, the biosensor module 710 may include one or more light sources, one or more photodetectors, and one or more electrodes or conductive elements that are configured to detect and measure a physiological condition or property of the user.

In some embodiments, the rear cover 608 has an edge that protrudes outwardly from the back surface of the housing 601. The rear cover 608 may also have a convex curved area located between the edges of the rear cover 608. The convex curved area of the rear cover 608 may include one or more windows or apertures that provide operational access to one or more internal components located within the housing 601.

In some embodiments, the windows have a curvature that matches the curvature of the convex curved area of the rear cover.

## 2. Example Housing

As described above, a wearable electronic device may include a device body that includes a housing or enclosure shell. As previously described, the housing may function as a chassis that physically integrates the various components of the device. The housing may also form a protective shell or housing for the components and function as a barrier against moisture or debris. In the present examples, the housing is formed as a uni-body, unitary, or single body or component. A single-body construction may be advantageous by providing mounting features directly into the housing, which may reduce space, reduce part count, and increase structural rigidity as compared to some alternative configurations. Additionally, a single-body construction may improve the housing's ability to prevent the ingress of moisture or debris by reducing or eliminating seams or joints between external components.

FIG. 8 depicts an example housing 601 in accordance with some embodiments. In the present example, the housing 601 is formed as a single body or component. As shown in FIG. 8, the housing 601 is formed as a single part or body. The housing 601 may be formed, for example, by machining or shaping a solid or cast blank having the approximate shape of the housing 601. In some implementations, the housing 601 may be configured to provide structural integrity for potentially delicate internal components and also withstand a reasonable impact.

In the present embodiment, the housing 601 is formed as a uni-body, unitary, or single-body construction having a flat bottom portion 801 and a top portion including flange 812. The top portion defines an internal cavity 805, which is surrounded by four sides 802a-d that are integrally formed with the bottom portion 801. The internal cavity 805 can also be described as being defined by the top portion, the four sides 802a-d and the bottom portion 801. In this example, the internal cavity 805 has a rectangular (square) shape, although the specific shape may vary with different implementations. In the present example, the four sides 802a-d define a curved side portion of the housing 601 that extends from the bottom portion 801 to the top portion of the housing 601. Each side 802a-d is orthogonal to an adjacent side and each side 802a-d is connected to an adjacent side by a rounded corner. For example, side 802a is orthogonal to two adjacent sides 802b and 802d and is connected to those sides by respective rounded corners. The shape or contour of the rounded corners may correspond to the curvature of the curved portion of the housing 601. Specifically, the curvature of the rounded corners may match or correspond to the curvature of the continuous external surface formed by the housing 601 and the cover 609, as described above with respect to FIG. 6.

The sides 802a-d may vary in thickness in order to provide the structural rigidity for the device. In general, areas of high stress may have an increased material thickness as compared to areas of low stress, which may have a reduced material thickness. In particular, portions of the sides 802a-d near the bottom portion 801 may have an increased thickness as compared to portions of the sides 802a-d located further away from the bottom portion 801. This configuration may improve the structural rigidity and overall stiffness of the housing 601.

## US 11,474,483 B2

31

As shown in FIG. 8, one or more mounting features may be formed directly into the housing 601, which may reduce the number of parts and also enhance the structural integrity of the device. As shown in FIG. 8, receiving features 623, 624 may be formed as channels or openings that are configured to receive an end of a band (e.g., a lug) having a mating feature. As described above with respect to FIG. 5, the receiving features 623, 624 may be standardized and configured to work with a system of interchangeable components. Forming the receiving features 623, 624 directly into the housing 601 may reduce parts and also facilitate structural rigidity of the device.

In the example depicted in FIG. 8, the housing 601 can be described as having two ends (a first end and a second end opposite the first end), and a first side and a second side opposite the first side, the sides being continuous with the ends. In this example, the first and second ends and the first and second sides having an outwardly curved three-dimensional shape. In this example, the receiving feature 623 is formed from a first groove situated in the first end. Similarly, the receiving feature 624 is formed from a second groove situated in the second end. In the present example the grooves have openings at the interface of the first and second sides and first and second ends. As shown in FIG. 8 the groove also has an inwardly curved concave three-dimensional shape with an undercut feature. For example, the middle portion of the groove of receiving features 623, 624 may have a width that is greater than the opening of the receiving features 623, 624. In some embodiments, the upper portion of the housing overhangs the lower portion of the housing at the groove opening. In the example depicted in FIG. 8, the groove is cut into a solid portion of the housing such that the groove forms a continuous interior shape.

The geometry of the receiving features may be located with respect to other features or components of the device. In the example depicted in FIG. 8, at least a portion of the groove of the receiving features 623, 624 may be disposed underneath the cover (item 609 of FIGS. 6-7). With respect to FIG. 6, the groove of the receiving features 623, 624 is located underneath the opening for the cover, which is defined by the sealing ledge 810 and flange 812 formed in the upper portion of the housing 601. In some embodiments, the length of the groove extends further than the width of the opening configured to receive the cover (and thus the cover, when assembled). In some embodiments, the grooves are formed at an angle relative to the centerline of the housing. In some cases, the angle is approximately 5 degrees. In some embodiments, the groove is located underneath the centerline of the housing 601. In some embodiments, the groove is angled upward toward the top of the housing 601 and inward toward the center of the housing 601. The groove 601 may angle upward and cross the centerline of the housing. In some cases, the groove crosses the vertical centerline of the housing 601.

In the present embodiment, the housing 601 also includes an aperture 821 formed into the side 802c of the housing 601 for attaching a crown or crown module (item 642 of FIGS. 6-7). In some embodiments, the aperture 821 for the crown is offset upwardly from the centerline of the housing 601. In some embodiments, the aperture 821 for the crown is positioned such that an upper portion of a crown (when installed) is higher than the interface of cover 609 and housing 601. With respect to FIG. 6, the interface may correspond to the upper edge of the flange 812.

The housing 601 also includes an opening 822 formed into the side 802c of the housing 601 for attaching the button (item 644 of FIGS. 6-7). In some embodiments, the aperture

32

821 for the crown and the opening 822 for the button are disposed with the length defined by a flat part of the cover. In some embodiments, the aperture 821 for the crown is disposed above the centerline of the housing 601 and the opening 822 for the button is disposed below the centerline of the housing 601. In some embodiments, the aperture 821 for the crown and the opening 822 for the button are disposed on a curved surface of the housing 601. The housing 601 may also include various other internal features, including threaded features and bosses, for attaching other internal components of the device.

In some cases, the housing 601 may be formed as a single-piece or integral enclosure shell to enhance the structural rigidity and/or liquid-sealing properties of the device. As described above with respect to FIGS. 6 and 7, the housing 601 may be integrated with a cover (e.g., crystal) and other external components to provide a substantially sealed housing. In the present embodiment, the housing 601, includes a sealing ledge 810 formed around the perimeter of the main cavity 805 formed within the housing 601. In some embodiments, the sealing ledge 810 (and thus the cover when installed) is located in the center of the housing 601. The sealing ledge 810 may be defined by a substantially flat portion 811 that is adapted to form a seal between the housing 601 and another component (e.g., the force sensor 705 or cover 609 of FIGS. 6-7). The sealing ledge 810 may be formed at a depth that is substantially similar or corresponds to the thickness of the mating cover.

As shown in FIG. 8, the sealing ledge 810 may also include flange 812 that protrudes from the flat portion and forms a continuous surface with the side walls 802a-d. In some cases, the flange 812 is configured to cooperate with the cover (item 609 of FIGS. 6-7) to form a substantially continuous surface. In some implementations, the sides 802a-d and the cover or crystal are configured to cooperate or mechanically interface to improve the strength and the water sealing properties of the device.

As also shown in FIG. 8, an opening or aperture 815 may be formed in the bottom portion 801 of the housing 601. In some embodiments, the opening or aperture 815 is located at the center of the housing 601. As described above with respect to FIG. 7, the aperture 815 may be used to integrate a sensor array or other module used to collect measurements that may be used to compute a health metric or other health-related information. The present embodiment may be advantageous by integrating multiple components in a single opening 815, which may facilitate a water-proof or water-resistant property of the device. Additionally, by integrating a sensor array into a module that attaches via the opening 815, same housing 601 may be used with a variety of sensing configurations or arrays. For example, the number or sensors or components may be increased or decreased without modifying the housing 601. This may allow for flexibility in the product development and may facilitate upgrades as new sensing configurations are available.

As previously discussed above with respect to FIGS. 6-7, the housing 601 may also be configured to serve as a protective housing for one or more acoustic elements, such as a microphone or speaker. Additionally, in some embodiments, the housing 601 may also be configured to inhibit the ingress of foreign particulate or moisture. In particular, the housing 601 may include a speaker port having orifices 831, 832 that are configured to transmit acoustic signals but also prevent the ingress of liquid or other foreign particulate. In the present example, the speaker port includes orifices 831, 832 that are offset with respect to an acoustic chamber or cavity to prevent the direct ingress of liquid into the speaker



subassembly or acoustic module. In the present example, a shielding or umbrella portion of the housing, which is substantially free of openings, is formed between the orifices **831**, **832**, which helps to prevent the direct ingress of liquid. Similarly, the housing **601** includes a microphone port having orifices **833**, **834** that are offset from a corresponding acoustic chamber or cavity to prevent the direct ingress of liquid into the microphone subassembly or acoustic module.

In the example depicted in FIG. **8**, the orifices **831**, **832** of the speaker port are located on one side of the aperture **821** for the crown and the orifices **833**, **834** for the microphone are located on the other side of the aperture **821**. Both the orifices **831**, **832** of the speaker port and the orifices **833**, **834** for the microphone are located on a curved portion of the housing **601**.

### 3. Example Force Sensor and Touch Sensor

As discussed previously, a wearable electronic device may include one or more sensors for detecting the location and force of a touch. For the purposes of the following description of the force sensor and touch sensor, the described device **100** is one example of that shown and discussed above with respect to FIGS. **2-7**. However, certain features of the device **100** including the external surface geometry, may be simplified or vary with respect to aspects of the device **100** discussed above.

In some embodiments, a force sensor and a touch sensor may be disposed relative to the display of a wearable electronic device for to form a touch-sensitive surface. The following description is provided with respect to individual force and touch sensors that may be used to determine the force and location of a touch, respectively. However, in some embodiments, a single integrated sensor may be used to detect both the force and location of a touch on the device.

In one embodiment, an output from a force sensor may be combined with a touch sensor to provide both location and force of a single touch or of multiple touches on the surface of a device. In an alternative embodiment, a hybrid or integrated force and touch sensor may be used to sense both touch force and location of a single touch or of multiple touches. In either embodiment, by sensing both the force and location of a touch, multiple types of user input may be generated and interpreted. In one example, a first touch may be correlated with a first force and a first touch location or gesture. Based on the magnitude of the force, the first touch may be interpreted as a first type of input or command. A second touch may be sensed as having a second, different force and a similar location or gesture as the first touch. Based in part on the magnitude of the second force, the second touch may be interpreted as a second type of input or command. Thus, a force sensor (alone or in combination with another touch sensor) may be used to produce different responses or outputs depending on the force of the touch.

The one or more force sensors may be formed from or may be implemented as one or more types of sensor configurations. For example, capacitive and/or strain based sensor configurations may be used alone or in combination to detect and measure the magnitude of a touch. As described in more detail below, a capacitive force sensor may be configured to detect the magnitude of a touch based on the displacement of a surface or element on the device. Additionally or alternatively, a strain-based force sensor may be configured to detect the magnitude of a touch based on a deflection of the surface, such as the cover glass.

By way of example, the force sensor may include a capacitive force sensor, which may be formed from one or

more capacitive plates or conductive electrodes that are separated by a compressible element or other compliant member. As a force is applied to a surface of the device, the compressible element may deflect resulting in a predictable change in the capacitance between the plates or electrodes. In some implementations, a capacitive force sensor may be formed from transparent materials and disposed over the display. In other implementations, a capacitive force sensor may be formed from non-transparent materials and disposed beneath or around the perimeter of a display.

FIG. **9** depicts a detail cross-sectional view of a portion of a force sensor **900** that may be arranged around the perimeter of a display **120**. As shown in FIG. **9**, a force-sensing structure **901** of the force sensor **900** may be disposed beneath the cover **609** and along the side of an edge or the perimeter of the display **120**. In this example, the force sensor **900** is configured to detect and measure the force of a touch on the surface **911** of the cover **609**. In the present embodiment, a first capacitive plate **902** is fixed with respect to the cover **609**. A second, lower capacitive plate **904** is fixed with respect to the housing **601** and may be disposed on a shelf or mounting surface located along the perimeter of the device. The first capacitive plate **902** and the second capacitive plate **904** are separated by a compressible element **906**.

In the configuration depicted in FIG. **9**, a touch on the surface **911** of the device may cause a force to be transmitted through the cover **609** of the device and to the force sensor **900**. In some cases, the force causes the compressible element **906** to compress, thereby bringing the first capacitive plate **902** and the second capacitive plate **904** closer together. The change in distance between the first and second capacitive plates **902**, **904** may result in a change of capacitance, which may be detected and measured. For example, in some cases, a force-sensing circuit may measure this change in capacitance and output a signal that corresponds to the measurement. A processor, integrated circuit or other electronic element may correlate the circuit output to an estimate of the force of the touch. Although the term "plate" may be used to describe certain elements, such as the capacitive plates or conductive electrodes, it should be appreciated that the elements need not be rigid but may instead be flexible (as in the case of a trace or flex).

FIG. **10A** depicts an example configuration of the force sensor **1000** having four individual force-sensing structures **1001a-d** arranged around the perimeter of a display in a device. For the sake of clarity, the crystal, display, and other elements of the device are omitted from the depiction of FIG. **10A**. Each of the force-sensing structures **1001a-d** may be formed from a pair of capacitive plates separated by a compressible element. Additionally, each force-sensing structure **1001a-d** may be separated by a small gap at or near the corners of the opening in the housing **601**. In the example depicted in FIG. **10A**, the four individual force-sensing structures **1001a-d** may each be operatively coupled to force-sensing circuitry that is configured to detect a change in the capacitance of each force-sensing structure **1001a-d**. Using the example arrangement depicted in FIG. **10A**, the approximate location of the touch may be determined by comparing the relative change in capacitance of each force-sensing structure **1001a-d**. For example, a change in capacitance of structure **1001b** that is larger as compared to a change in capacitance of structure **1001d** may indicate that the touch is closer to structure **1001b**. In some embodiments, the degree of the difference in the change in capacitance may be used to provide a more accurate location estimate.

US 11,474,483 B2

35

While the configuration shown in FIG. 10A depicts the force-sensing structures as individual elements separated by a small gap, in some embodiments, the force-sensing structure may be formed as a single continuous piece. FIG. 10B depicts a force sensor 1050 formed as a single force-sensing structure 1051 formed as a continuous part along the perimeter of the display. Similar to the example described above, the force-sensing structure 1051 may be operatively coupled to force sensing circuitry that is configured to detect a change in the capacitance of one or more capacitive elements of the force-sensing structure 1051. While the force-sensing structure 1051 is formed as a continuous structure, there may be multiple sensing elements (e.g., capacitive plates) that are disposed within the structure at different locations, and which may be configured to detect deflection or compression of the structure over a portion of entire area of the force-sensing structure 1051. In some embodiments, the force-sensing structure 1051 may also function as a seal or gasket to prevent ingress of moisture or other foreign contaminants into the main cavity of the housing. Additionally, the force-sensing structure 1051 may be integrated with one or more sealing or adhesive layers that also function as a barrier for foreign contaminants.

As mentioned previously, the force sensor may additionally or alternatively include a strain-based sensing configuration. The strain-based sensing configuration may include, for example, a charge-based or resistive sensor configuration. FIG. 11 depicts a cross-sectional view of a device having an example force sensor 1100 that uses one or more force-sensitive films to detect and measure the force of a touch on a surface 1111 of the cover 609. In this example, the force sensitive film 1102 and 1104 are formed from a transparent material and are disposed relative to a viewable portion of the display 120. As shown in FIG. 11, the force sensor 1100 includes a first force-sensitive film 1102 and a second force-sensitive film 1104 that are separated by one or more intermediate layers 1106. The force-sensitive films 1102, 1104 may be configured to produce different electrical outputs in response to a strain or deflection of the cover 609. In some cases, the intermediate layer 1106 is compressible to allow the first force-sensitive film 1102 to deflect with respect to the second force-sensitive film 1104. In other cases, the intermediate layer 1106 may not be compressible and the first force-sensitive film 1102 deflects in a predictable manner with respect to the second force-sensitive film 1104. While FIG. 11 depicts an example force sensor 1100 having two force-sensitive films, alternative embodiments may include only a single force-sensitive film or, alternatively, include more than two force-sensitive films.

In general, a transparent force-sensitive film may include a compliant material that exhibits an electrical property that is variable in response to deformation or deflection of the film. The transparent force-sensitive film may be formed from a piezoelectric, piezo-resistive, resistive, or other strain-sensitive materials. Transparent resistive films can be formed by coating a substrate with a transparent conductive material. Potential transparent conductive materials include, for example, polyethyleneoxythiophene (PEDOT), indium tin oxide (ITO), carbon nanotubes, graphene, silver nanowire, other metallic nanowires, and the like. Potential substrate materials include, for example, glass or transparent polymers like polyethylene terephthalate (PET) or cycloolefin polymer (COP). Typically, when a piezo-resistive or resistive film is strained, the resistance of the film changes as a function of the strain. The resistance can be measured

36

with an electrical circuit. In this way, a transparent piezo-resistive or resistive film can be used in a similar fashion as a strain gauge.

If transparency is not required, then other film materials may be used, including, for example, Constantan and Karma alloys for the conductive film and a polyimide may be used as a substrate. Nontransparent applications include force sensing on track pads or the back of display elements. In general, transparent and non-transparent force-sensitive films may be referred to herein as "force-sensitive films" or simply "films."

In some embodiments, the force-sensitive film is patterned into an array of lines, pixels, or other geometric elements herein referred to as film elements. The regions of the force-sensitive film or the film elements may also be connected to sense circuitry using electrically conductive traces or electrodes. FIG. 12 depicts a cross-sectional view a device having a strain-based force sensor 1200 formed from one or more strain pixel elements 1202 and 1204 separated by intermediate layer 1206. Each of the pixel elements 1202, 1204 may be separated by a gap 1210. In the present example, each pixel element 1202, 1204 may exhibit a measurable change in an electrical property in response to a force being applied to the device. By way of example, as a force is applied to a surface 1211 on the cover 609, one or more of the pixel elements 1202, 1204 is deflected or deformed. Sense circuitry, which is in electrical communication with the one or more pixel elements 1202, 1204, may be configured to detect and measure the change in the electrical property of the film due to the deflection. Based on the measured electrical property of the pixel elements 1202, 1204, an estimated amount of force can be computed. In some cases, the estimated force may represent the magnitude of a touch on the surface 1211 of the device, and be used as an input to a graphical user interface or other element of the device. Additionally, in some embodiments, the relative strain of the individual pixel elements may be compared to estimate a location of the touch. While FIG. 12 depicts an example force sensor 1200 having two layers of pixel elements, alternative embodiments may include only a single layer of pixel elements or, alternatively, include more than two layers of pixel elements.

The pixel elements 1202, 1204 may be specifically configured to detect strain along one or more directions. In some cases, each pixel element 1202, 1204 includes an array of traces generally oriented along one direction. This configuration may be referred to as a piezo-resistive or resistive strain gauge configuration. In general, in this configuration the force-sensitive-film is a material whose resistance changes in response to strain. The change in resistance may be due to a change in the geometry resulting from the applied strain. For example, an increase in length combined with decrease in cross-sectional area may occur in accordance with Poisson's effect. The change in resistance may also be due to a change in the inherent resistivity of the material due to the applied strain. For example, the applied strain may make it easier or harder for electrons to transition through the material. The overall effect is for the total resistance to change with strain due to the applied force.

Further, in a piezo-resistive or resistive strain gauge configuration, each pixel may be formed from a pattern of the force-sensitive-film, aligned to respond to strain along a particular axis. For example, if strain along an x-axis is to be measured, the pixel should have a majority of its trace length aligned with the x-axis. By way of example, FIG. 13A depicts a pixel element 1302 having traces that are generally oriented along the x-axis and may be configured to produce

US 11,474,483 B2

37

a strain response that is substantially isolated to strain in the x-direction. Similarly, FIG. 13B depicts a pixel element 1304 having traces that are generally oriented along the y-axis and may be configured to produce a strain response that is substantially isolated to strain in the y-direction.

In some embodiments, the force-sensitive film may be formed from a solid sheet of material and is in electrical communication with a pattern of electrodes disposed on one or more surfaces of the force-sensitive film. The electrodes may be used, for example, to electrically connect a region of the solid sheet of material to sense circuitry. This configuration may be referred to as a piezo-strain configuration. In this configuration, the force-sensitive film may generate a charge when strained. The force-sensitive film may also generate different amounts of charge depending on the degree of the strain. In some cases, the overall total charge is a superposition of the charge generated due to strain along various axes.

As mentioned previously, a force sensor may be combined with a touch sensor that is configured to detect and measure the location of a touch on the surface of the device. FIG. 14A depicts a simplified schematic representation of an example mutual capacitance touch sensor. As shown in FIG. 14A, a touch sensor 1430 may be formed by an array of nodes 1402 formed at the intersection of an array of drive lines 1404 and sense lines 1406. In this example, stray capacitance  $C_{stray}$  may be present at each node 1402 (although FIG. 14A depicts only one  $C_{stray}$  for one column for purposes of simplifying the figure). In the example of FIG. 14A, AC stimuli  $V_{stim}$  1414,  $V_{stim}$  1415 and  $V_{stim}$  1417 can be at different frequencies and phases. Each stimulation signal on a row can cause a charge  $Q_{sig} = C_{sig} \times V_{stim}$  to be injected into the columns through the mutual capacitance present at the affected nodes 1402. A change in the injected charge ( $Q_{sig\_sense}$ ) can be detected when a finger, palm or other object is present at one or more of the affected nodes 1402.  $V_{stim}$  signals 1414, 1415 and 1417 can include one or more bursts of sine waves. Note that although FIG. 14A illustrates rows 1404 and columns 1406 as being substantially perpendicular, they need not be aligned, as described above. Each column 1406 may be operatively coupled to a receive channel of a charge-monitoring circuit.

FIG. 14B depicts a side view of an exemplary node in a steady-state (no touch) condition according to examples of the disclosure. In FIG. 14B, electric field lines 1408 between a column 1406 and a row 1404 separated by dielectric 1410 is shown at node 1402.

FIG. 14C depicts a side view of an exemplary pixel in a dynamic (touch) condition. An object such as finger 1412 can be placed near node 1402. Finger 1412 can be a low-impedance object at signal frequencies, and can have an AC capacitance  $C_{finger}$  from the column trace 1406 to the body. The body can have a self-capacitance to ground  $C_{body}$  of about 200 pF, where  $C_{body}$  can be much larger than  $C_{finger}$ . If finger 1412 blocks some electric field lines 1408 between row and column electrodes (those fringing fields that exit the dielectric 1410 and pass through the air above the row electrode), those electric field lines can be shunted to ground through the capacitance path inherent in the finger and the body, and as a result, the steady state signal capacitance  $C_{sig}$  can be reduced by  $DC_{sig}$ . In other words, the combined body and finger capacitance can act to reduce  $C_{sig}$  by an amount  $DC_{sig}$  (which can also be referred to herein as  $C_{sig\_sense}$ ), and can act as a shunt or dynamic return path to ground, blocking some of the electric field lines as resulting in a reduced net signal capacitance. The signal capacitance at the pixel becomes  $C_{sig-DC_{sig}}$ , where  $DC_{sig}$  represents the

38

dynamic (touch) component. Note that  $C_{sig-DC_{sig}}$  may always be nonzero due to the inability of a finger, palm or other object to block all electric fields, especially those electric fields that remain entirely within the dielectric material. In addition, it should be understood that as finger 1412 is pushed harder or more completely onto the touch sensor, finger 1412 can tend to flatten, blocking more and more of the electric fields lines 1408, and thus  $DC_{sig}$  may be variable and representative of how completely finger 1412 is pushing down on the panel (i.e., a range from "no-touch" to "full-touch").

Additionally or alternatively, the touch sensor may be formed from an array of self-capacitive pixels or electrodes. FIG. 15A depicts an example touch sensor circuit corresponding to a self-capacitance touch pixel electrode and sensing circuit. Touch sensor circuit 1509 can have a touch pixel electrode 1502 with an inherent self-capacitance to ground associated with it, and also an additional self-capacitance to ground that can be formed when an object, such as finger 1512, is in proximity to or touching the touch pixel electrode 1502. The total self-capacitance to ground of touch pixel electrode 1502 can be illustrated as capacitance 1504. Touch pixel electrode 1502 can be coupled to sensing circuit 1514. Sensing circuit 1514 can include an operational amplifier 1508, feedback resistor 1516, feedback capacitor 1510 and an input voltage source 1506, although other configurations can be employed. For example, feedback resistor 1516 can be replaced by a switch capacitor resistor. Touch pixel electrode 1502 can be coupled to the inverting input of operational amplifier 1508. An AC input voltage source 1506 can be coupled to the non-inverting input of operational amplifier 1508. Touch sensor circuit 1509 can be configured to sense changes in the total self-capacitance 1504 of touch pixel electrode 1502 induced by finger 1512 either touching or in proximity to the touch sensor panel. Output 1520 can be used by a processor to determine a presence of a proximity or touch event, or the output can be inputted into a discreet logic network to determine the presence of a touch or proximity event.

FIG. 15B depicts an example self-capacitance touch sensor 1530. Touch sensor 1530 can include a plurality of touch pixel electrodes 1502 disposed on a surface and coupled to sense channels in a touch controller, can be driven by stimulation signals from the sense channels through drive/sense interface 1525, and can be sensed by the sense channels through the drive/sense interface 1525 as well. After touch controller has determined an amount of touch detected at each touch pixel electrode 1502, the pattern of touch pixels in the touch screen panel at which touch occurred can be thought of as an "image" of touch (e.g., a pattern of fingers touching the touch screen). The arrangement of the touch pixel electrodes 1502 in FIG. 15B is provided as one example; however, the arrangement and/or the geometry of the touch pixel electrodes may vary depending on the embodiment.

As previously mentioned, a force sensor may be implemented alone or in combination with another type of touch sensor to sense both touch force and touch location, which may enable more sophisticated user touch input than using touch location alone. For example, a user may manipulate a computer-generated object on a display using a first type of interaction using a relatively light touch force at a given touch location. The user may also interact with the object using a second type of interaction by using a relatively heavy or sharper touch force at the given location. As one specific example, a user may manipulate or move a computer-generated object, such as a window, using a relatively light



US 11,474,483 B2

39

touch force. Additionally or alternatively, the user may also select or invoke a command associated with the window using a relatively heavy or sharper touch force. In some cases, multiple types of interactions may be associated with multiple amounts of touch force.

Additionally, it may be advantageous for the user to be able to provide an analog input using a varying amount of force. A variable, non-binary input may be useful for selecting within a range of input values. The amount of force may, in some cases, be used to accelerate a scrolling operation, a zooming operation, or other graphical user interface operation. It may also be advantageous to use the touch force in a multi-touch sensing environment. In one example, the force of a touch may be used to interpret a complex user input performed using multiple touches, each touch having a different magnitude or degree of force. As a specific but non-limiting example, touch and force may be used in a multi-touch application that allows the user to play a varying tone or simple musical instrument using the surface of the device. In such a housing, the force of each touch may be used to interpret a user's interaction with the buttons or keys of a virtual instrument. Similarly, the force of multiple touches can be used to interpret a user's multiple touches in a game application that may accept multiple non-binary inputs at different locations.

#### 4. Sensor or Biosensor Module

As described above with respect to FIG. 2, a wearable electronic device may include one or more sensors that can be used to calculate a health metric or other health-related information. For the purposes of the following description of the biosensor module, the described device 100 is one example of that shown and discussed above with respect to FIGS. 2-7. However, certain features of the device 100 including the external surface geometry, may be simplified or vary with respect to aspects of the device 100 discussed above.

In some embodiments, a wearable electronic device may function as a wearable health assistant that provides health-related information (whether real-time or not) to the user, authorized third parties, and/or an associated monitoring device. The wearable health assistant may be configured to provide health-related information or data such as, but not limited to, heart rate data, blood pressure data, temperature data, blood oxygen saturation level data, diet/nutrition information, medical reminders, health-related tips or information, or other health-related data. The associated monitoring device may be, for example, a tablet computing device, phone, personal digital assistant, computer, and the like.

In accordance with some embodiments, the electronic device can be configured in the form of a wearable electronic device that is configured or configurable to provide a wide range of functionality. As described above with respect to FIG. 2, the wearable electronic device 100 may include a processing units 102 coupled with or in communication with a memory 104, one or more communications channels 108, output devices such as a display 120 and speaker 122, one or more input components 106, and other modules or components. An example wearable electronic device 100 may be configured to provide or calculate information regarding time, health information, biostatistics, and/or status to externally connected or communicating devices and/or software executing on such devices. The device 100 may also be configured to send and receive messages, video, operating commands, and other communications.

40

With reference to FIG. 16, an example device 100 may include various sensors for measuring and collecting data that may be used to calculate a health metric or other health-related information. As one example, the wearable communication device can include an array of light sources 1611-1613 and a detector 1614 that are configured to function as an optical sensor or sensors. In one example, an optical sensor or sensors may implemented as a pairing of one or more light sources 1611-1613 and the detector 1614. In one example implementation, the detector 1614 is configured to collect light and convert the collected light into an electrical sensor signal that corresponds to the amount of light incident on a surface of the detector 1614. In one embodiment, the detector may be a photodetector, such as a photodiode. In other embodiments, the detector 1614 may include a phototube, photosensor, or other light-sensitive device.

In some cases, the one or more optical sensors may operate as a photoplethysmography (PPG) sensor or sensors. In some instances, a PPG sensor is configured to measure light and produce a sensor signal that can be used to estimate changes in the volume of a part of a user's body. In general, as light from the one or more light sources passes through the user's skin and into the underlying tissue, some light is reflected, some is scattered, and some light is absorbed, depending on what the light encounters. The light that is received by the detector 1614 may be used to generate a sensor signal, which may be used to estimate or compute a health metric or other physiological phenomena.

The light sources may operate at the same light wavelength range, or the light sources can operate at different light wavelength ranges. As one example, with two light sources, one light source may transmit light in the visible wavelength range while the other light source can emit light in the infrared wavelength range. In some cases, a modulation pattern or sequence may be used to turn the light sources on and off and sample or sense the reflected light. With reference to FIG. 16, the first light source 1611 may include, for example, a green LED, which may be adapted for detecting blood perfusion in the body of the wearer. The second light source 1612 may include, for example, an infrared LED, which may be adapted to detect changes in water content or other properties of the body. The third 1613 light source may be a similar type or different types of LED element, depending on the sensing configuration.

The optical (e.g., PPG) sensor or sensors may be used to compute various health metrics, including, without limitation, a heart rate, a respiration rate, blood oxygenation level, a blood volume estimate, blood pressure, or a combination thereof. In some instances, blood may absorb light more than surrounding tissue, so less reflected light will be sensed by the detector of the PPG sensor when more blood is present. The user's blood volume increases and decreases with each heartbeat. Thus, in some cases, a PPG sensor may be configured to detect changes in blood volume based on the reflected light, and one or more physiological parameters of the user may be determined by analyzing the reflected light. Example physiological parameters include, but are not limited to, heart rate, respiration rate, blood hydration, oxygen saturation, blood pressure, perfusion, and others.

While FIG. 16 depicts one example embodiment, the number of light sources and/or detectors may vary in different embodiments. For example, another embodiment may use more than one detector. Another embodiment may also use fewer or more light sources than are depicted in the example of FIG. 16. In particular, in the example depicted in FIG. 16, the detector 1614 is shared between multiple light

## US 11,474,483 B2

41

sources **1611-1613**. In one alternative embodiment, two detectors may be paired with two corresponding light sources to form two optical sensors. The two sensors (light source/detector pairs) may be operated in tandem and used to improve the reliability of the sensing operation. For example, output of the two detectors may be used to detect a pulse wave of fluid (e.g., blood) as it passes beneath the respective detectors. Having two sensor readings taken at different locations along the pulse wave may allow the device to compensate for noise created by, for example, movement of the user, stray light, and other effects.

In some implementation, one or more of the light sources **1611-1613** and the detector **1614** may also be used for optical data transfer with a base or other device. For example, the detector **1614** may be configured to detect light produced by an external mating device, which may be interpreted or translated into a digital signal. Similarly, one or more of the light sources **1611-1613** may be configured to transmit light that may be interpreted or translated into a digital signal by an external device.

Returning to FIG. 16, the device **100** may also include one or more electrodes to measure electrical properties of the user's body. In this example, a first electrode **1601** and second electrode **1602** are disposed on the rear face of the device **100**. The first **1601** and second **1602** electrodes may be configured to make contact with the skin of the user's wrist when the device is being worn. As shown in FIG. 16, a third electrode **1603** and fourth electrode **1604** may be disposed along a periphery of the device body **610**. In the configuration of FIG. 16, the third **1603** and fourth **1604** electrodes are configured to come into contact with the skin of the user's other hand (that is not wearing the device **100**). For example, the third **1603** and fourth **1604** electrodes may be contacted when the user pinches the device **100** between two digits (e.g., a forefinger and thumb).

FIG. 16 depicts one example arrangement of electrodes. However, in other embodiments, one or more of the electrodes may be placed in locations that are different than the configuration of FIG. 16. For example, one or more electrodes may be placed on a top surface or other surface of the device **100**. Additionally, fewer electrodes or more electrodes may be used to contact the user's skin, depending on the configuration.

Using the electrodes of the device, various electrical measurements may be taken, which may be used to compute a health metric or other health-related information. By way of example, the electrodes may be used to detect electrical activity of the user's body. In some cases, the electrodes may be configured to detect electrical activity produced by the heart of the user to measure heart function or produce an electrocardiograph (ECG). As another example, the electrodes of the device may be used to detect and measure conductance of the body. In some cases, the measured conductance may be used to compute a galvanic skin response (GSR), which may be indicative of the user's emotional state or other physiological condition. By way of further example, the electrodes may also be configured to measure other health characteristics, including, for example, a body fat estimate, body or blood hydration, and blood pressure.

In some embodiments, the optical sensors and electrodes discussed above with respect to FIG. 16 may be operatively coupled to sensing circuitry and the processing units **102** to define a health monitoring system. In this capacity, the processing units **102** may be any suitable type of processing device. In one embodiment, the processing units **102** include a digital signal processor. The processing units **102** may

42

receive signals from the optical sensor(s) and/or electrodes and process the signals to correlate the signal values with a physiological parameter of the user. As one example, the processing units **102** can apply one or more demodulation operations to the signals received from the optical sensor. Additionally, the processing units **102** may control the modulation (i.e., turning on and off) of the light sources according to a given modulation pattern or sequence. The processing units **102** may also be used to calculate one or more biometrics or other health related information.

In some implementations, the wearable electronic device may also receive sensor data or output from an external device. For example, an external mobile device having a global positioning system (GPS) may relay location information to the wearable device, which may be used to calibrate an activity metric, such as a pedometer or distance calculator. Similarly, sensor output of the wearable electronic device may be transmitted to an external device to compute health-related information. For example, output from an accelerometer in the wearable electronic device may be used to determine a body position or gesture, which may be relayed to an external device and used to compute health-related information, such as activity level.

In some embodiments, some or all of the biosensors may be integrated into a module that is separate from and attached to the housing **601** of the device **100**. As described above with respect to FIG. 6, in some embodiments, the biosensors are disposed relative to or attached to a rear cover **608** that is formed from an optically transparent material and is configured to be positioned with the opening of the housing **601**. In some embodiments, the rear cover **608** is disposed completely within the area of the cover so that the two components completely overlap when viewed from above. In some embodiments, the rear cover **608** has an edge that protrudes outwardly from the back surface of the housing **601**. In some embodiments, an edge of the rear cover **608** extends past a flat portion of the back surface of the housing **601**. The rear cover **608** may also have a convex, curved outer contour. The rear cover **608** may have a convex shape that is located within the center and surrounded by the edges of the rear cover **608**. The convex curved area of the rear cover **608** may include one or more windows or apertures that provide operational access to one or more internal components located within the housing. For example, the rear cover **608** may include an array of windows, each window including an aperture or opening for a respective light source **1611-1613** and/or the detector **1614**. In some embodiments, the windows have a curvature that matches the curvature of the convex curved area of the rear cover **608**. In some embodiments, rear cover **608** includes a chamfered edge and a curved bottom surface, the windows being disposed within the curved surface. In some embodiments, two openings of the rear cover **608** are located along a first axis (e.g., an x-axis) and two openings are located along a second axis (e.g., a y-axis) that is transverse to the first axis.

#### 5. Example Wireless Communications with External Devices

A wearable electronic device may include a functionality for performing wireless communications with an external device. For the purposes of the following description, the described device **100** is one example of that shown and discussed above with respect to FIGS. 2-7. However, certain features of the device **100**, including the external surface

geometry, may be simplified or vary with respect to aspects of the device **100** discussed above.

In some embodiments, the wireless communications are performed in accordance with a Near Field Communications (NFC) protocol. The communication may include an identification protocol and a secured data connection that can be used to identify the user, authorize activity, perform transactions, or conduct other aspects of electronic commerce.

FIG. 17 depicts an example system **1700** including a device **100** that is located proximate to a station **1710**. The station **1710** may include a variety of devices, including, without limitation, a payment kiosk, a vending machine, a security access point, a terminal device, or other similar device. In some cases, the station **1710** is incorporated into a larger system or device. For example, the station **1710** may be incorporated into a security gate of a building or a payment center for a vending system.

As shown in FIG. 17, the device **100** is a wearable electronic device that may be placed proximate to the station **1710**. In this example, a second device **1720** is carried by a user, and may also be placed proximate to the station **1710**. In some embodiments, the device **100** and/or the second device **1720** includes a radio-frequency identification (RFID) system that is configured to enable one-way or two-way radio-frequency (RF) communications with the station **1710**. The one- or two-way communication may include an identification of the device **100** and the station **1710** to initiate a secured data connection between the two devices. The secured data connection may be used to authorize a transaction between the user and an entity that is associated with the station **1710**.

In some embodiments, the user may initiate a communication with the station **1710** by placing the device **100** near an active region on the station **1710**. In some implementations, the station **1710** is configured to automatically detect the presence of the device **100** and initiate an identification process or routine. The RFID system of the device may include a unique identifier or signature that may be used to authenticate the identity of the user. As previously mentioned, the identification process or routine may be used to establish a secure data connection between the device **100** and the station **1710**. The secure data connection may be used to authorize a purchase or download of data to or from the device **100**. In some cases, the secure data connection may be used to authorize the transfer of funds from a credit card or financial institution in exchange for a product that is associated with the station **1710**. Other transactions or forms of electronic commerce may also be performed using the wireless communication between the device **100** and the station **1710**.

## 6. Example Wireless Power System

As discussed above, a wearable electronic device may include an internal battery that is rechargeable using an external power source. For the purposes of the following description, the described device **100** is one example of that shown and discussed above with respect to FIGS. 2-7. However, certain features of the device **100**, including the external surface geometry, may be simplified or vary with respect to aspects of the device **100** discussed above.

One challenge associated with small devices is that it may be difficult to incorporate an electrical port for coupling the device to an external power source. Because wearable electronic devices have limited space for an external connector, it may be advantageous to electrically couple to a device without a cable or external connector. In at least some

embodiments, the wearable electronic device described herein may be configured to operate as a receiver in a wireless power transfer system.

A wireless power transfer system, one example of which is an inductive power transfer system, typically includes a power-transmitting structure to transmit power and a power-receiving structure to receive power. In some examples, a power-receiving electronic device includes or otherwise incorporates an inductive power-receiving element configured to receive wireless power and/or charge one or more internal batteries. Similarly, a charging device may include or otherwise incorporate an inductive power-transmitting element configured to wirelessly transmit power to the power-receiving electronic device. The charging device may be configured as a base or dock on which the power-receiving electronic device rests or to which it physically connects in some embodiments. In other embodiments, the charging device may be proximate the electronic device but not necessarily touching or physically coupled.

In many examples, the battery-powered electronic device may be positioned on an external surface of the power-transmitting device, otherwise referred to as a dock. In these systems, an electromagnetic coil within the dock (e.g., transmit coil) may produce a time-varying electromagnetic flux to induce a current within an electromagnetic coil within the electronic device (e.g., receive coil). In many examples, the transmit coil may transmit power at a selected frequency or band of frequencies. In one example the transmit frequency is substantially fixed, although this is not required. For example, the transmit frequency may be adjusted to improve inductive power transfer efficiency for particular operational conditions. More particularly, a high transmit frequency may be selected if more power is required by the electronic device and a low transmit frequency may be selected if less power is required by the electronic device. In other examples, a transmit coil may produce a static electromagnetic field and may physically move, shift, or otherwise change its position to produce a spatially-varying electromagnetic flux to induce a current within the receive coil.

The electronic device may use the received current to replenish the charge of a rechargeable battery or to provide power to operating components associated with the electronic device. Thus, when the electronic device is positioned on the dock, the dock may wirelessly transmit power at a particular frequency via the transmit coil to the receive coil of the electronic device.

A transmit coil and receive coil may be disposed respectively within housings of the dock and electronic device so as to align along a mutual axis when the electronic device is placed on the dock. If misaligned, the power transfer efficiency between the transmit coil and the receive coil may decrease as misalignment increases. Accordingly, in many examples, the wireless power transfer system may include one or more alignment assistance features to effect alignment of the transmit and receive coils along the mutual axis.

FIG. 18 depicts a front perspective view of an example wireless power transfer system **1800** in an unmated configuration. The illustrated embodiment shows an inductive power transmitter dock **1802** that is configured to couple to and wirelessly transmit power to an inductive power receiver accessory, in this case device **100**. The wireless power transfer system **1800** may include one or more alignment assistance features to effect alignment of the device **100** with the dock **1802** along a mutual axis. For example, the housings of the dock **1802** and the device **100** may assist with alignment. In one implementation, a portion



US 11,474,483 B2

45

of the housing of the device 100 may engage and/or interlock with a portion of the housing of the dock 1802 in order to effect the desired alignment. In some embodiments, a bottom portion of the device 100 may be substantially convex and a top surface of the dock 1802 may be substantially concave. In other examples, the interfacing surfaces of the dock 1802 and the device 100 may be substantially flat, or may include one or more additional housing features to assist with effecting mutual alignment.

In some embodiments, one or more actuators in the dock 1802 and/or device 100 can be used to align the transmitter and receiver devices. In yet another example, alignment assistance features, such as protrusions and corresponding indentations in the housings of the transmitter and receiver devices, may be used to align the transmitter and receiver devices. The design or configuration of the interface surfaces, one or more alignment assistance mechanisms, and one or more alignment features can be used individually or in various combinations thereof.

Alignment assistance can also be provided with one or more magnetic field sources. For example, a permanent magnet within the dock 1802 may attract a permanent magnet within the device 100. In another example, a permanent magnet within the device 100 may be attracted by a magnetic field produced by the dock 1802. In further examples, multiple alignment assistance features may cooperate to effect alignment of the transmit and receive coils. Power transfer efficiency may also decrease if the power consumption of the electronic device changes (e.g., the electronic device transitions from a trickle charge mode to constant current charge mode) during wireless power transfer.

As discussed previously with respect to FIG. 2, the device 100 may include a processor coupled with or in communication with a memory, one or more communication interfaces, output devices such as displays and speakers, and one or more input devices such as buttons, dials, microphones, or touch-based interfaces. The communication interface(s) can provide electronic communications between the communications device and any external communication network, device or platform, such as, but not limited to, wireless interfaces, Bluetooth interfaces, Near Field Communication interfaces, infrared interfaces, USB interfaces, Wi-Fi interfaces, TCP/IP interfaces, network communications interfaces, or any conventional communication interfaces. The device 100 may provide information regarding time, health, statuses or externally connected or communicating devices and/or software executing on such devices, messages, video, operating commands, and so forth (and may receive any of the foregoing from an external device), in addition to communications.

In the example depicted in FIG. 18, the dock 1802 may be connected to an external power source, such as an alternating current power outlet, by power cord 1808. In other embodiments, the dock 1802 may be battery operated. In still further examples, the dock 1802 may include a power cord 1808 in addition to an internal or external battery. Similarly, although the embodiment is shown with the power cord 1808 coupled to the housing of the dock 1802, the power cord 1808 may be connected by any suitable means. For example, the power cord 1808 may be removable and may include a connector that is sized to fit within an aperture or receptacle opened within the housing of the dock 1802.

Although the device 100 is shown in FIG. 18 as larger than the dock 1802, the depicted scale may not be representative of all embodiments. For example, in some embodiments the dock 1802 may be larger than the device 100. In

46

still further embodiments the two may be substantially the same size and shape. In other embodiments, the dock 1802 and device 100 may take separate shapes.

FIG. 19 depicts a simplified block diagram of relevant aspects of the device 100 and dock 1802. It may be appreciated that certain components of both the dock 1802 and device 100 are omitted from the figure for clarity. Likewise, the positions of the elements that are shown are meant to be illustrative rather than necessarily portraying a particular size, shape, scale, position, orientation, or relation to one another, although some embodiments may have elements with one or more of such factors as illustrated.

As described previously with respect to FIG. 2, the device 100 may include one or more electronic components located within the housing 601. For clarity, some of the components and modules described or depicted in various embodiments are omitted from the depiction of FIG. 19. As shown in FIG. 19, the device 100 may include an internal battery 114 that may be used to provide power to the various internal components of the device 100. As described previously, the internal battery 114 may be rechargeable by an external power supply. In the present example, the internal battery 114 is operably connected to a receive coil 1869 via power conditioning circuit 1810.

In the present example, the device 100 includes a receive coil 1869 having one or more windings for inductively coupling with a transmit coil 1832 of the dock 1802. The receive coil 1869 may receive power wirelessly from the dock 1802 and may pass the received power to a battery 114 within the device 100 via power conditioning circuit 1810. The power conditioning circuit 1810 may be configured to convert the alternating current received by the receive coil 1869 into direct current power for use by other components of the device. In one example, the processing units 102 may direct the power, via one or more routing circuits, to perform or coordinate one or more functions of the device 100 typically powered by the battery 114.

As shown in FIG. 19, the dock 1802 includes a transmit coil 1832 having one or more windings. The transmit coil 1832 may transmit power to the device 100 via electromagnetic induction or magnetic resonance. In many embodiments, the transmit coil 1832 may be shielded with a shield element that may be disposed or formed around portions of the transmit coil 1832. Similarly, the receive coil 1869 may also include a shield element that may be disposed or formed around a portion of the receive coil 1869.

As shown in FIG. 19, the dock 1802 also includes a processor 1834 that may be used to control the operation of or coordinate one or more functions of the dock 1802. In some embodiments, the dock 1802 may also include one or more sensors 1836 to determine whether the device 100 is present and ready to receive transmitted power from the dock 1802. For example, the dock 1802 may include an optical sensor, such as an infrared proximity sensor. When the device 100 is placed on the dock 1802, the infrared proximity sensor may produce a signal that the processor 1834 uses to determine the presence of the device 100. The processor 1834 may, optionally, use another method or structure to verify the presence of the electronic device via sensor 1836. Examples of different sensors that may be suitable to detect or verify the presence of device 100 may include a mass sensor, a mechanical interlock, switch, button or the like, a Hall effect sensor, or other electronic sensor. Continuing the example, after the optical sensor reports that the device 100 may be present, the processor 1834 may activate a communication channel to attempt to communicate with the device 100.

US 11,474,483 B2

47

As illustrated in FIG. 19, a bottom surface of the housing of the device 100 may partially contact a top surface of the dock housing. In some implementations, the interfacing surfaces of the device 100 and the dock 1802 may be formed with complementary geometries. For example, as depicted in FIG. 19, the bottom surface of the device 100 is convex and the top surface of the dock 1802 is concave, following the same curvature as the bottom surface of the device 100. In this manner, the complementary geometries may facilitate alignment of the electronic device and dock for efficient wireless power transfer.

In some embodiments, the dock 1802 and device 100 may include other alignment assistance features. For example the device 100 may include an alignment magnet 1838 which is positioned and oriented to attract a corresponding alignment magnet 1840 within the dock 1802. In some cases, when the device 100 is positioned proximate the dock 1802, the alignment magnets 1838, 1840 may be mutually attracted, thereby affecting alignment of the portable electronic device 100 and the dock 1802 along a mutual axis. In other examples, the dock 1802 may include a ferromagnetic material in place of the alignment magnet 1840. In these examples, the alignment magnet 1838 may be attracted to the ferromagnetic material. In still further cases, the receive coil 1869 or transmit coil 1832 may produce a static magnetic field that either attracts or repels either or both of the alignment magnets 1838, 1840.

As shown in FIG. 19, the alignment magnets 1838, 1840 may be positioned within a respective coil 1869, 1832. When the alignment magnets 1838, 1840 are drawn together, the coils 1869, 1832 may be placed into alignment. Additionally, the complementary geometries of the device 100 and the dock 1802 may further facilitate alignment when the alignment magnets 1838, 1840 are drawn together.

#### 7. Example Acoustic Module

As described above, the device may include one or more devices for transmitting and receiving acoustic energy. For the purposes of the following description of the acoustic module, the described device 100 is one example of that shown and discussed above with respect to FIGS. 2-7. However, certain features of the device 100, including the external surface geometry, may be simplified or vary with respect to aspects of the device 100 discussed above. As previously discussed, in some embodiments, the device may include a speaker for transmitting acoustic energy and/or a microphone for receiving acoustic energy. For the purposes of the following description, a speaker device and a microphone are referred to generically as an acoustic module, which may be configured to transmit and/or receive acoustic energy depending on the particular implementation.

FIG. 20 depicts a simplified schematic cross-sectional view of a first embodiment of a device having an acoustic module 2006. The representation depicted in FIG. 20 is not drawn to scale and may omit some elements for clarity. The acoustic module 2006 may represent either a portion of a speaker and/or microphone device described above with respect to the electronic device 100 of FIG. 2.

As shown in FIG. 20, an acoustic port 2020 may be formed in the housing 601 of the electronic device. In the present example, the acoustic port 2020 includes first and second orifices 2031, 2032 that are formed in the housing 601 and acoustically couple the acoustic cavity 2011 of the acoustic module 2006 to the external environment (external to the electronic device). In the present embodiment, the first and second orifices 2031, 2032 are offset with respect to the

48

opening of the acoustic cavity 2011. This configuration may help reduce the direct ingress of liquid 2001 into acoustic cavity 2011 of the acoustic module 2006. Also, as shown in FIG. 20 a shield 2021 or umbrella structure that is formed between the orifices 2031, 2032 blocks the direct ingress of liquid 2001 into the acoustic cavity 2011. As shown in FIG. 20, the acoustic module 2006 also includes a screen element 2015 disposed at one end of the acoustic cavity 2011, which may also prevent the ingress of liquid or other foreign debris into the acoustic cavity 2011. The acoustic module 2006 also includes a seal 2016 disposed between the housing 601 and the connector element 2012 of the module, which may also be configured to prevent the ingress of water into the device and/or module.

In the present example depicted in FIG. 20, the acoustic module 2006 may correspond to the speaker 122 described with respect to some embodiments. As shown in FIG. 20, the acoustic module 2006 includes various components for producing and transmitting sound, including a diaphragm 2010, a voice coil 2009, a center magnet 2008, and side magnets/coils 2007. These components may cooperate to form a speaker acoustic element. In one implementation, the diaphragm 2010 is configured to produce sound waves or an acoustic signal in response to a stimulus signal in the center magnet 2008. For example, a modulated stimulus signal in the center magnet 2008 causes movement of the voice coil 2009, which is coupled to the diaphragm 2010. Movement of the diaphragm 2010 creates the sound waves, which propagate through the acoustic cavity 2011 of acoustic module 2006 and eventually out the acoustic port 2020 to a region external to the device. In some cases, the acoustic cavity 2011 functions as an acoustical resonator having a shape and size that is configured to amplify and/or dampen sound waves produced by movement of the diaphragm 2010.

As shown in FIG. 20, the acoustic module 2006 also includes a yoke 2014, support 2013, connector element 2012, and a cavity wall 2017. These elements provide the physical support of the speaker elements. Additionally, the connector element 2012 and the cavity wall 2017 together form at least part of the acoustic cavity 2011. The specific structural configuration of FIG. 20 is not intended to be limiting. For example, in alternative embodiments, the acoustic cavity may be formed from additional components or may be formed from a single component.

The acoustic module 2006 depicted in FIG. 20 is provided as one example of a type of speaker acoustic module. In other alternative implementations, the acoustic module may include different acoustic elements for producing and transmitting sound, including, for example, a vibrating membrane, piezoelectric transducer, vibrating ribbon, or the like. Additionally, in other alternative implementations, the acoustic module may be a microphone acoustic module having one or more elements for converting acoustic energy into an electrical impulse. For example, the acoustic module may alternatively include a piezoelectric microphone acoustic element for producing a charge in response to acoustic energy or sound.

As previously mentioned, because the acoustic port 2020 connects the acoustic module 2006 to the external environment, there is a possibility that liquid may accumulate or infiltrate the interior of the module. In some cases, the screen element 2015 or other protective features may not prevent all liquid from entering the acoustic cavity 2011 of the module. For example, if the device is subjected to a liquid under pressure or a directed stream of liquid, some liquid ingress may occur. Additionally, naturally occurring mois-

US 11,474,483 B2

49

ture in the air may condense and accumulate over time resulting in the presence of liquid within the module. Thus, in some implementations, the acoustic module 2006 may include one or more elements configured to expel water or liquid that accumulates in, for example, the acoustic cavity 2011 of the module. The liquid expulsion process may include modifying the charge on a portion of the wall of the acoustic cavity 2011 to change the surface energy of the wall and/or producing an acoustic pulse using the diaphragm 2010 to help expel liquid from the acoustic cavity 2011. In some embodiments, the screen 2015 may also have hydrophilic or hydrophobic properties that may facilitate removal of liquid held within the acoustic cavity 2011.

#### 8. Example Antenna and Cover

As previously described, a wearable electronic device may be configured to communicate wirelessly with various external devices and communication networks. For the purposes of the following description, the described device 100 is one example of that shown and discussed above with respect to FIGS. 2-7. However, certain features of the device 100, including the external surface geometry, may be simplified or vary with respect to aspects of the device 100 discussed above.

In some embodiments, as previously discussed with respect to FIG. 2, the device may include one or more communication channels that are configured to transmit and receive data and/or signals over a wireless communications network or interface. Example wireless interfaces include radio frequency cellular interfaces, Bluetooth interfaces, Wi-Fi interfaces, or any other known communication interface.

In some implementations an antenna may be disposed with respect to the cover (e.g., crystal) of a device to facilitate wireless communications with an external device or communication network. In some cases, it may be advantageous to integrate an antenna into the cover to improve the transmission and reception of wireless signals from the device. In particular, the cover of the device may have dielectric properties that facilitate the transmission of radio frequency signals while also protecting the antenna from physical damage or interference. Additionally, if the antenna is integrated into a perimeter portion of the cover, the visual appearance or clarity of the cover may be minimized. Furthermore, the embodiments described below with respect to FIGS. 21A-B may be used to integrate an antenna external to the housing, without increasing the thickness of the device body.

FIG. 21A depicts a perspective exploded view of a cover 2100 and an antenna assembly 2130. The cover 2100 depicted in FIG. 21A is viewed from an inner surface 2124 that is configured to attach to or interface with the opening of the housing (described above with respect to FIG. 1). As shown in FIG. 21A, a groove 2128 may be formed within the inner surface 2124. In this example, the groove 2128 is formed around the periphery of the cover 2100. As mentioned previously, this may be advantageous in minimizing the visual impact of having the antenna assembly 2130 located within the cover 2100.

As shown in FIG. 21A the antenna assembly 2130 includes an antenna ring 2134 and a terminal 2140 which may interface with an electrical connector 2150. In the present embodiment, the groove 2128 formed in the surface of the cover 2100 may be configured to accept the antenna ring 2134. In particular, the groove 2128 may receive the entire antenna ring 2134 without a portion of the antenna

50

ring 2134 protruding past the inner surface 2124, when the antenna ring 2134 is installed. In some cases, the groove 2128 is formed to be a clearance or near clearance fit with the diameter of the antenna ring 2134. Thus, in some cases, the antenna ring 2134 may substantially fill the groove 2128 when the ring is installed. In some cases, the groove 2128 may be configured to retain the antenna ring 2134 due to a slight interference fit or due to a feature formed within either the cover 2100 and/or the antenna assembly 2130. In the present embodiment, the antenna assembly 2130 may be installed in the cover 2100 and then connected to other electronics via the terminal 2140 and the connector 2150, which may protrude into an opening in the case or housing.

FIG. 21B depicts a cross-sectional view of the cover and antenna at the connection point. In particular, FIG. 21B depicts a detail cross-sectional view of the cover 2100 installed within the housing 601 at a region near the terminal 2140. In this example, the cover 2100 is attached to a shelf of the housing 601 via a compressible element 2122. The compressible element 2122 may provide a seal against water or other contaminants and also provide compliance between the cover 2100 and the housing 601. The compressible element 2122 may be formed from a nitrile or silicone rubber and may also include an adhesive or other bonding agent.

As shown in FIG. 21B, the antenna ring 2134 is disposed entirely within the groove 2128. In this case, the antenna ring 2134 does not protrude past the inner surface 2124. The antenna ring 2134 is electrically connected to the terminal 2140, which protrudes into an opening in the housing 601. As shown in FIG. 21B, the terminal 2140 includes conductive pads 2142 for electrically connecting to the antenna ring 2134. In this example, spring clips 2152 are configured to mechanically and electrically connect to the conductive pads 2142 on the terminal 2140. One advantage to the configuration depicted in FIG. 21B is that the antenna assembly 2130 may be installed in the cover 2100 before the cover 2100 is installed in the housing 601. The terminal 2140 and connector 2150 facilitate a blind connection that may assist electrical connection as the cover 2100 is installed. Additionally, the configuration depicted in FIG. 21B may allow for some movement between the cover 2100 and the housing 601 without disturbing the electrical connection with the antenna ring 2134.

#### 9. Example Haptic Module

As described above, the device may include one or more haptic modules for providing haptic feedback to the user. The embodiments described herein may relate to or take the form of durable and thin haptic feedback elements suitable to provide a perceivable single pulse haptic feedback. In general, a haptic device may be configured to produce a mechanical movement or vibration that may be transmitted through the housing and/or other component of the device. In some cases, the movement or vibration may be transmitted to the skin of the user and perceived as a stimulus or haptic feedback by the user. In some implementations, the haptic feedback may be coupled to one or more device outputs to alert the user of an event or activity. For example, a haptic output may be produced in combination with an audio output produced by the speaker, and/or a visual output produced using the display.

The space constraints associated with a small wrist-worn device may present unique challenges to integrating a haptic mechanism into wearable electronics. In particular, a haptic mechanism may use a moving mass used to create the



US 11,474,483 B2

51

movement or vibration of the haptic output. The larger the mass that is moved, the easier it may be to create a perceivable stimulus using the haptic mechanism. However, a large moving mass and the supporting mechanism may be difficult to integrate into the compact space of, for example, the housing of a wearable electronic wristwatch.

Thus, the haptic module implemented in some embodiments may be configured to maximize the mechanical energy that is produced in a very compact form factor. FIGS. 22A-B depict one example haptic mechanism that may be particularly well suited for use in a wearable electronic device. While the embodiment described with respect to FIGS. 22A-B is provided as one example, the haptic module is not limited to this particular configuration.

FIG. 22A depicts a three-quarters perspective view of a haptic device 112, with a top, front and left sidewall of the housing 2220 removed to expose internal components. FIG. 22B depicts a cross-sectional perspective view of the haptic device 112 cut in half to expose the internal components. In this example, a coil 2200 is used to induce movement of a frame 2260, which houses a central magnet array 2210. As shown in FIGS. 22A-B, the movement of the frame 2260 is guided by a shaft 2250 that is fixed with respect to a housing 2220.

In the present example, the coil 2200 may be energized by transmitting a current (e.g., from the battery) along a length of a wire that forms the coil 2200. A direction of the current along the wire of the coil 2200 determines a direction of a magnetic field that emanates from the coil 2200. In turn, the direction of the magnetic field determines a direction of movement of the frame 2260 housing the central magnet array 2210. One or more springs may bias the frame 2260 towards the middle region of the travel. In this example, the frame 2260 and central magnet array 2210, through operation of the coil 2200, function as a moving mass, which generates a tap or vibration. The output of the haptic device 112, created by the moving mass of the frame 2260 and central magnet array 2210, may be perceived as a haptic feedback or stimulus to the user wearing the device.

For example, when the coil 2200 is energized, the coil 2200 may generate a magnetic field. The opposing polarities of the magnets in the magnet array 2210 generates a radial magnetic field that interacts with the magnetic field of the coil 2200. The Lorentz force resulting from the interaction of the magnetic fields causes the frame 2260 to move along the shaft 2250 in a first direction. Reversing current flow through the coil 2200 reverses the Lorentz force. As a result, the magnetic field or force on the central magnet array 2210 is also reversed and the frame 2260 may move in a second direction. Thus, frame 2260 may move in both directions along the shaft 2250, depending on the direction of current flow through the coil 2200.

As shown in FIG. 22A, the coil 2200 encircles the central magnet array 2210, which is disposed near the center of the frame 2260. As previously described, the coil 2200 may be energized by transmitting a current along the length of the wire forming the coil 2200, and the direction of the current flow determines the direction of the magnetic flux emanating from the coil 2200 in response to the current. Passing an alternating current through the coil 2200 may cause the central magnet array 2210 (and frame 2260) to move back and forth along a shaft 2250. In order to prevent the central magnet array 2210 from being attracted to the shaft 2250, which could increase friction between the two and thereby increase the force necessary to move the central magnet

52

array 2210 and frame 2260, the shaft 2250 may be formed from a non-ferrous material such as tungsten, titanium, stainless steel, or the like.

As depicted in FIGS. 22A-B, the coil 2200 is positioned within a frame 2260 that holds the central magnet array 2210, but is not affixed to the coil 2200. Rather, an air gap separates the coil 2200 from the central magnet array 2210 and the frame 2260 is free to move with respect to the coil 2200, which is generally stationary. Further, the frame 2260 generally moves with the central magnet array 2210. As illustrated in FIGS. 22A-B, the frame 2260 may have an aperture formed therein of sufficient size to contain the coil 2200. Even when the frame and central magnet array are maximally displaced within the housing 2220 (e.g., to one end or the other of the shaft 2250), the coil 2200 does not contact any portion of the frame 2260. It should be appreciated that the coil 2200 remains stationary in the housing 2220 while the frame 2260 and central magnet array 2210 move, although in other embodiments the coil 2200 may move instead of, or in addition to, the frame and/or central magnet array. However, by keeping the coil 2200 stationary, it may be easier to provide interconnections for the coil, such as between the coil and the flex, and therefore reduce the complexity of manufacture.

As shown in FIGS. 22A-B, the central magnet array 2210 may be formed from at least two magnets 2211, 2212 of opposing polarities. A center interface 2270 may be formed from a ferrous or non-ferrous material, depending on the embodiment. A ferrous material for the center interface 2270 may enhance the overall magnetic field generated by the central magnet array 2210, while a non-ferrous material may provide at least a portion of a return path for magnetic flux and thus assist in localizing the flux within the housing 2220. In some embodiments, the magnets 2211, 2212 are formed from neodymium while the frame is tungsten. This combination may provide a strong magnetic field and a dense mass, thereby yielding a high weight per volume structure that may be used as the moving part of the haptic device 112.

#### 10. Example Crown Module

As described above, the device may include a crown that may be used to accept user input to the device. For the purposes of the following description, the described device 100 is one example of that shown and discussed above with respect to FIGS. 2-7. However, certain features of the device 100, including the external surface geometry, may be simplified or vary with respect to aspects of the device 100 discussed above.

In some embodiments, a crown may be used to accept rotary input from the user, which may be used to control aspects of the device. The crown may be knurled or otherwise textured to improve grip with the user's finger and/or thumb. In some embodiments, a crown may be turned by the user to scroll a display or select from a range of values. In other embodiments, the crown may be rotated to move a cursor or other type of selection mechanism from a first displayed location to a second displayed location in order to select an icon or move the selection mechanism between various icons that are output on the display. In a time keeping application, the crown may also be used to adjust the position of watch hands or index digits displayed on the display of the device. The crown may also be used to control the volume of a speaker, the brightness of the display screen, or control other hardware settings.

In some embodiments, the crown may also be configured to accept linear, as well as rotary, input. For example, the

US 11,474,483 B2

53

crown may be configured to translate along an axis when pressed or pulled by the user. In some cases, the linear actuation may be used as additional user input. The actuation may provide a binary output (actuated/not actuated) or may also provide a non-binary output that corresponds to the amount of translation along the axis of motion. In some instances, the linear input to the crown may be combined with the rotary input to control an aspect of the device.

The embodiments described herein may be used for at least a portion of the crown module integrated into a wearable electronic device. The embodiments are provided as examples and may not include all of the components or elements used in a particular implementation. Additionally, the crown module is not intended to be limited to the specific examples described below and may vary in some aspects depending on the implementation.

In some embodiments, an optical encoder may be used to detect the rotational motion of the crown. More specifically, the example provided below with respect to FIG. 23 may use an optical encoder to detect rotational movement, rotational direction and/or rotational speed of a component of the electronic device. Once the rotational movement, rotational direction and/or rotational speed have been determined, this information may be used to output or change information and images that are presented on a display or user interface of the electronic device.

Integrating an optical encoder into the space constraints of a typical wearable electronic device may be particularly challenging. Specifically, some traditional encoder configurations may be too large or delicate for use in a portable electronic device. The optical encoder described below may provide certain advantages over some traditional encoder configurations and may be particularly well suited for use with a crown module of a wearable electronic device.

As shown in the example embodiment of FIG. 23, the optical encoder of the present disclosure includes a light source 2370, a photodiode array 2380, and a shaft 2360. However, unlike typical optical encoders, the optical encoder of the present disclosure utilizes an encoding pattern disposed directly on the shaft 2360. For example, the encoding pattern includes a number of light and dark markings or stripes that are axially disposed along the shaft 2360. Each stripe or combination of stripes on the shaft 2360 may be used to identify a position of the shaft 2360. For example, as light is emitted from the light source 2370 and reflected off of the shaft 2360 into the photodiode array 2380, a position, rotation, rotation direction and rotation speed of the shaft 2360 may be determined. Once the rotation direction and speed are determined, this information may be used to output or change information or images that are presented on the display or user interface of the electronic device.

In other embodiments, the shape or form of the shaft of the encoder may be used to determine a position, rotation, rotation direction and rotation speed of the shaft. For example, the shaft may be fluted or have a number of channels that cause the light to be reflected in a number of different directions. Accordingly, a diffractive pattern may be used to determine the rotation, rotation direction and rotation speed of the shaft.

FIG. 23 illustrates a simplified depiction of the device 100 and crown module 642 in accordance with some embodiments. As shown in FIG. 23, the crown module 642 may be integrated with the housing 601 of the device 100 and may be formed from a dial 2340 disposed at the end of a shaft 2360. In the present embodiment, the crown module 642 also forms part of the optical encoder. As discussed above, the crown module 642 includes an optical encoder that

54

includes a shaft 2360, a light source 2370, and a photodiode array 2380. Although a photodiode array is specifically mentioned, embodiments disclosed herein may use various types of sensors that are arranged in various configurations for detecting the movement described herein. For example, the movement of the shaft 2360 may be detected by an image sensor, a light sensor such as a CMOS light sensor or imager, a photovoltaic cell or system, photo resistive component, a laser scanner and the like.

The optical encoder may produce an encoder output that is used to determine positional data of the crown module 642. In particular, the optical encoder may produce an output that is used to detect that movement of the dial 2340 including the direction of the movement, speed of the movement and so on. The movement may be rotational movement, translational movement, angular movement, and so on. The optical encoder may also be used to detect the degree of the change of rotation of the dial 2340 and/or the angle of rotation of the dial 2340 as well as the speed and the direction of the rotation of the dial 2340.

The signals or output of the optical encoder may be used to control various aspects of other components or modules of the device. For example, continuing with the time keeping application example discussed above, the dial 2340 may be rotated in a clockwise manner in order to advance the displayed time forward. In one implementation, the optical encoder may be used to detect the rotational movement of the dial 2340, the direction of the movement, and the speed at which the dial 2340 is being rotated. Using the output from the optical encoder, the displayed hands of a time keeping application may rotate or otherwise move in accordance with the user-provided rotational input.

Referring back to FIG. 23, the crown module 642 may be formed from dial 2340 that is coupled to the shaft 2360. In some cases, the shaft 2360 and dial 2340 may be formed as a single piece. As the shaft 2360 is coupled to, or is otherwise a part of the dial 2340, as the dial 2340 rotates or moves in a particular direction and at a particular speed, the shaft 2360 also rotates or moves in the same direction and with the same speed.

As shown in FIG. 23, the shaft 2360 of the optical encoder includes an encoding pattern 2365. As discussed above, the encoding pattern 2365 may be used to determine positional information about the shaft 2360 including rotational movement, angular displacement and movement speed. As shown in FIG. 23, the encoding pattern 2365 may include a plurality of light and dark stripes.

Although light stripes and dark stripes are specifically mentioned and shown, the encoding pattern 2365 may consist of various types of stripes having various shades or colors that provide surface contrasts. For example, the encoding pattern 2365 may include a stripe or marking that has a high reflective surface and another stripe that has a low reflective surface regardless of the color or shading of the stripes or markings. In another embodiment, a first stripe of the encoding pattern 2365 may cause specular reflection while a second stripe of the encoding pattern 2365 may cause diffuse reflection. When the reflected light is received by the photodiode array 2380, a determination may be made as to the position and movement of the shaft such as described below. In embodiments where a holographic or diffractive pattern is used, the light from the light source 2370 may diffract from the shaft 2360. Based on the diffracted light, the photodiode array 2380 may determine the position, movement and direction of movement of the shaft 2360.



US 11,474,483 B2

55

In some embodiments, the stripes of the encoding pattern **2365** extend axially along the shaft **2360**. The stripes may extend along the entire length of the shaft **2360** or partially along a length of the shaft **2360**. In addition, the encoding pattern **2365** may also be disposed around the entire circumference of the shaft **2360**. In other embodiments, the encoding pattern **2365** may include a radial component. In yet other embodiments, the encoding pattern **2365** may have both a radial component and an axial component.

In some embodiments, the crown module may also include a tactile switch for accepting translational input from the user. FIGS. **24A-B** depict another example of a crown module **642a** having a tactile switch assembly **2410**. As shown in FIG. **24A**, the tactile switch assembly **2410** may include a dial **2448** (or button), a coupling **2418**, a shear plate **2456**, and a tactile switch **2414**.

In the embodiment depicted in FIGS. **24A-B**, the dial **2448** is translatable and/or rotatable relative to the housing. The ability of the dial **2448** to translate and rotate relative to the housing allows a user to provide a rotational force and/or translating force to the tactile switch assembly. In particular, the dial **2448** of the present example may be operably coupled to or form part of an optical encoder, in accordance with the example described above with respect to FIG. **23**.

In the present example, the dial **2448** includes an outer surface **2432** that is configured to receive a rotary or rotational user input and a stem **2450** that extends from an interior surface **2434** of the dial **2448**. The stem **2450** may define a coupling aperture that extends longitudinally along a length or a portion of a length of the stem **2450**. In the depicted example, the stem **2450** may be hollow or partially hollow.

In the example depicted in FIGS. **24A-B**, the coupling **2418** may be a linkage, such as a shaft, that couples the dial **2448** to the tactile switch **2414**. The coupling **2418** may be integrally formed with the dial **2448** or may be a separate component operably connected thereto. For example, the stem **2450** of the dial **2448** may form the coupling member that is integrally formed with the dial **2448**. The coupling **2418** may be made of a conductive material, such as one or more metals or metal alloys. Due to the conductive characteristics, the coupling **2418** may further act to electrically couple the dial **2448** to the tactile switch **2414** and shear plate **2456**. In the example depicted in FIGS. **24A-B**, the shear plate **2456** is positioned between the coupling **2418** and the tactile switch **2414**. In some embodiments, the shear plate **2456** may prevent or reduce shearing forces from the coupling from being transmitted to the tactile switch. The shear plate **2456** also allows transfer of linear force input from the dial **2448** to the switch **2414**.

The configuration depicted in FIGS. **24A-B** may be used to accept both rotational and translational input from the user. For example, if a user provides a rotational force to the dial **2448**, the coupling **2418** and dial **2448** may rotate in the direction of the force. The coupling **2418** may be attached to or integrated with one or more sensors that are configured to detect rotational movement. For example the coupling **2418** may be integrated with an optical encoder, similar to the example described above with respect to FIG. **23**. Additionally, if a user provides a translational force to the dial **2448**, the force may be transmitted through the dial **2448** and coupling **2418** to actuate the switch **2414**. In some cases, the switch **2414** includes a metal dome switch that is configured to provide a tactile feedback when actuated. In some cases, the actuation of a dome switch may be perceived by the user as a click or release as the switch **2414** is actuated. Once the force has been removed from the dial **2448**, the dome switch

56

resiliently returns to its original position, providing a biasing force against the coupling **2418** to return both the dial **2448** and the coupling **2418** to their original positions. In some embodiments, the tactile switch **2414** may include a separate biasing element, such as a spring, that exerts a force (either directly or indirectly via the shear plate) against the coupling. FIG. **24A** depicts the tactile switch assembly **2410** when there is no force applied (un-actuated). FIG. **24B** depicts the tactile switch assembly **2410** when there is a translational force applied to the dial **2448** (actuated).

#### 11. Example Band Attachment Mechanism

For the purposes of the following description, the described device **100** is one example of that shown and discussed above with respect to FIGS. **2-7**. However, certain features of the device **100**, including the external surface geometry, may be simplified or vary with respect to aspects of the device **100** discussed above.

As described above, a wearable electronic device may include a band that is attached to a device body having one or more receiving features. In particular, the housing may include or form a receiving feature that facilitates an interchange or replacement of different bands that are used to secure the device to the wrist of the user. By replacing or interchanging bands the device may be adapted for multiple uses ranging from sporting activities to professional or social activities.

In some embodiments, the receiving features are configured to be operated without the use of special tools or fixtures. For example, the bands may be interchanged by hand or with the help of a simple tool, such as a pointed object. Additionally or alternatively, a tool or other component, such as a component of the device to which the attachment system is coupled, may be configured to actuate a button or other component of the attachment system to secure and/or release the band from the device. In one embodiment, the lug portion of a band may be configured to be inserted into an opening or channel portion of the receiving feature. Once the lug of the band has been inserted into the opening, the lug may slide within the opening of the device until the band is secured or otherwise coupled to the device. The coupling between the band and the receiving feature may provide a secure attachment of the band to the housing or device body. Just as the band is configured to slide into the channel of the receiving feature, the lug may also slide out of the channel of the receiving feature allowing the band to be detached from the device body.

In one embodiment, the receiving feature includes a locking mechanism, which may be integrated with portions of either the band or the receiving feature. In one example, as the band is inserted into a receiving feature of the device, the locking mechanism interfaces with a portion of the receiving feature to lock or otherwise secure the band within the receiving feature. The locking mechanism may also be configured to interface with a releasing mechanism associated with the receiving feature. For example, a releasing mechanism may be configured to disengage or release the locking mechanism. In some implementations, actuation of the releasing mechanism causes the locking mechanism to be released and allows the band to be removed by sliding within the receiving feature.

FIG. **25A** depicts a receiving feature and band assembly as viewed from the bottom of the device body. As shown in FIG. **25A**, a receiving feature **623a** includes an opening or channel **2501** that is formed into the body or housing of the device. The channel **2501** is configured to receive the lug

US 11,474,483 B2

57

2510 attached to an end of the band strap 621a. The receiving feature 623a may also include a locking mechanism 2530 that is configured to maintain the band strap 621a within the channel 2501 once it has been installed. As discussed above, the locking mechanism 2530 may be releasable by the user, which may facilitate band replacement. In this example, the locking mechanism 2530 includes a spring-loaded retaining mechanism that engages the lug 2510 to retain the lug 2510 in the channel 2501 and maintain the attachment of the band strap 621a to the device. As shown in FIG. 25A, the locking mechanism 2530 also includes a button located on the bottom of the housing that may be depressed by the user to release the locking mechanism and allow the lug 2510 and the band strap 621a to be removed from the channel 2501. In the present example, the button of the locking mechanism 2530 is located on a curved portion of the case or housing. In some embodiments, the button of the locking mechanism 2530 is located along the centerline of the case or housing.

In some embodiments, the opening or channel 2501 of the receiving feature 623a includes a port or connector for receiving a mating electrical component. In some embodiments, the connector or port is covered by a label or sticker so that the inside surface of the opening or channel 2501 appears continuous. The connector or port may be located along the vertical centerline of the case or housing.

FIG. 25B depicts an example exploded view of the receiving feature 623a and the lug 2510 of the band strap 621a. As shown in FIG. 25B, the band strap 621a may be formed from a separate part and attached to lug 2510 via a pivot or other type of joint. In other embodiments, the band strap 621a may have an end feature that is integrally formed as part of the band strap 621a. As also shown in FIG. 25B, the lug 2510 may be attached to the receiving feature 623a by aligning the axis of the lug 2510 with the axis of the channel 2501 and then sliding the lug 2510 into the channel 2501.

FIG. 25C depicts an example assembly sequence of the lug 2510 being inserted into the channel 2501 of the receiving feature 623a. As shown in FIG. 25C, the lug 2510 may be positioned along the side of the receiving feature 623a having the lug 2510 approximately aligned with the channel 2501 of the receiving feature 623a. The lug 2510 (and band strap 621a) may then be inserted into the channel 2501 of the receiving feature 623a by sliding the lug 2510 along the length of the channel 2501. Once the lug 2510 is approximately centered in the channel 2501 of the receiving feature 623a, the locking mechanism 2530 or other securing feature may engage, thereby retaining the lug 2510 (and band strap 621a) within the channel 2501. As previously discussed, the lug 2510 (and band strap 621a) may be removed from the receiving feature 623a by depressing the button of the locking mechanism 2530, which may disengage the lock and allow movement of the lug 2510 within the channel 2501.

The example described above is provided with respect to one example embodiment. The geometry of the end of the band strap and/or the geometry of the channel may vary depending on the implementation. Additionally, the engagement mechanism may vary depending on the design of the band strap and the device body. The geometry or layout of the features may vary and remain within the scope of the present disclosure. Additionally, while the examples provided above are described with respect to attaching a band strap to a device body, the receiving feature (623a) may be used to attach a variety of other parts to the device body. For

58

example a lanyard, cable, or other accessory may be attached to the device body using the receiving feature and other similar features.

## 12. Example Bands

As described above, a wearable electronic device may include a band that is used to secure the device to the wrist of a user. In some embodiments, the band may be formed from two band straps that are attached to the housing of the device body. The band straps may be secured around the wrist of a user by a clasp or latching mechanism. As also described above, the device may be configured to facilitate replacement of the band. This feature may allow the use of a variety of types of bands, which may adapt the device for multiple uses ranging from sporting activities to professional or social activities.

In some cases, the band may be formed from a woven textile material. In one example, the band is formed from a woven material that includes one or more strands or threads formed from a natural or synthetic material. The woven material may be formed, for example, from a plurality of warp threads that are woven around one or more weft threads. More specifically, the woven material may include a plurality of warp threads disposed along the length of the band, and at least one weft thread positioned perpendicular to, and coupled to, woven or interlaced between the plurality of warp threads. In some cases, the plurality of warp threads may run the entire length of the woven portion of the band strap. Additionally, in some cases, the at least one weft thread may include a single thread that may be continuously woven between the plurality of warp threads or, alternatively, may include a plurality of threads that may be woven between the plurality of warp threads. A weft thread that is woven between a plurality of warp threads may form consecutive cross-layers with respect to the plurality warp threads in order to form the band.

In some cases, one or more of the strands or threads may be a metallic or conductive material. This may improve the strength of the band and may also facilitate coupling with magnetic elements, such as a metallic clasp. In some cases, other elements may be woven into the band, including, for example, product identifying elements, decorative elements, or functional components.

In other embodiments, the band may be formed from a metallic mesh material. In one example, the metallic mesh is formed from an array of links that are interlocked to form a sheet of fabric. Some or all of the links in the mesh may be formed from a ferromagnetic material, which may facilitate magnetic engagement with a magnetic clasp. In some cases, each link of the mesh is formed from a section of metallic filament that is bent or formed into a closed shape. Each closed shape may be interlocked with one or more adjacent links to form a portion of the sheet or fabric. In some cases, a metallic filament is formed around a series of rods or pins that are disposed at a regular spacing within the mesh. In some cases, one or more strands or filaments that may be formed from a ferromagnetic material are woven or integrated with the links of the mesh.

In other examples, the band may be formed from a sheet of material. For example, the band may be formed from a synthetic leather, leather, or other animal hide. Additionally or alternatively, the band may be formed from a polymer material, an elastomer material, or other type of plastic or synthetic. In some cases, the band is formed from a silicone sheet material.

## US 11,474,483 B2

59

The clasp that is used to attach the free ends of the band straps may vary depending on the material that is used and the construction of the band. For example, as mentioned above, a metallic mesh material may use a metallic clasp to join the ends of the band. Additionally, a leather band may be integrated with magnetic and/or ferromagnetic components and may include a magnetic clasp. In some embodiments, the free ends of the band straps are secured using a buckle or tang on a first band strap that is configured to interface with a hole or aperture in a second band strap. A variety of other clasp configurations may also be used.

## 13. Example Display

For the purposes of the following description, the described device **100** is one example of that shown and discussed above with respect to FIGS. 2-7. However, certain features of the device **100**, including the external surface geometry, may be simplified or vary with respect to aspects of the device **100** discussed above. As described above, the device includes a display disposed within the housing or enclosure. The device may be formed from a liquid crystal display (LCD), organic light emitting diode (OLED) display, organic electroluminescence (OEL) display, or other type of display device. The display may be used to present visual information to the user, including, for example, a graphical user interface, notifications, health statistics, and the like. In some cases, the display may be configured to present the current time and date similar to a traditional watch or timepiece.

In some embodiments, the display is formed from an organic light emitting diode (OLED) display element. An active region of the display may include an array of light-emitting display pixels **2604** such as array **2602**, shown in FIG. 26. Pixels **2604** may be arranged in rows and columns in array **2602** and may be controlled using a pattern of control lines. Each pixel may include a light-emitting element such as organic light-emitting diode **2612** and associated control circuitry **2610**. Control circuitry **2610** may be coupled to the data lines **2606** and gate lines **2608** so that control signals may be received from driver circuitry, which may be implemented as an integrated circuit. Although described as an OLED display, certain embodiments may implement other display technology, such as LCD displays and the like.

To the extent that multiple functionalities, operations, and structures are disclosed as being part of, incorporated into, or performed by device **100**, it should be understood that various embodiments may omit any or all such described functionalities, operations, and structures. Thus, different embodiments of the device **100** may have some, none, or all of the various capabilities, apparatuses, physical features, modes, and operating parameters discussed herein.

Although the disclosure above is described in terms of various exemplary embodiments and implementations, it should be understood that the various features, aspects and functionality described in one or more of the individual embodiments are not limited in their applicability to the particular embodiment with which they are described, but instead can be applied, alone or in various combinations, to one or more of the other embodiments of the invention, whether or not such embodiments are described and whether or not such features are presented as being a part of a described embodiment. Thus, the breadth and scope of the present invention should not be limited by any of the above-described exemplary embodiments but instead defined by the claims herein presented.

60

We claim:

1. A wearable electronic device comprising:
  - a housing defining a first opening and a second opening;
  - a display positioned at least partially within the first opening;
  - a front cover positioned over the display and defining at least a portion of a front exterior surface of the wearable electronic device;
  - a biosensor module comprising:
    - a rear cover positioned at least partially within the second opening and defining an optically transparent window and a protruding convex surface;
    - an optical sensor aligned with the optically transparent window;
    - a first electrode positioned along a rear surface of the wearable electronic device; and
    - a second electrode positioned along the rear surface of the wearable electronic device; and
  - a third electrode positioned along a side of the wearable electronic device, wherein:
    - the wearable electronic device is configured to measure a first physiological parameter of a wearer using the optical sensor; and
    - the wearable electronic device is configured to measure a second physiological parameter using the first electrode, the second electrode, and the third electrode.
2. The wearable electronic device of claim 1, wherein:
  - the wearable electronic device further includes a watch band coupled to the housing and configured to couple the wearable electronic device to a wearer;
  - the optical sensor is a heart-rate sensor;
  - the first electrode is an electrode of an electrocardiograph sensing system; and
  - the second physiological parameter is an electrocardiogram.
3. The wearable electronic device of claim 1, further comprising an input device positioned along a side of the housing and configured to receive at least one of a rotational input or a translational input.
4. The wearable electronic device of claim 1, wherein the second physiological parameter is a galvanic skin response.
5. The wearable electronic device of claim 1, further comprising an input device positioned along a side of the housing and configured to receive at least one of a rotational input or a translational input.
6. The wearable electronic device of claim 1, wherein the optical sensor comprises:
  - an optical emitter configured to emit an optical signal; and
  - an optical receiver configured to receive a reflected portion of the optical signal.
7. The wearable electronic device of claim 6, wherein:
  - the optical emitter is a first optical emitter configured to emit light having a first wavelength; and
  - the optical sensor further comprises a second optical emitter configured to emit light having a second wavelength different from the first wavelength.
8. The wearable electronic device of claim 1, further comprising an input device positioned along a side of the housing and configured to receive a rotational input and a translational input.
9. The wearable electronic device of claim 1, further comprising a wireless charging system configured to receive power wirelessly, from an external charging dock, through the rear exterior surface of the wearable electronic device.



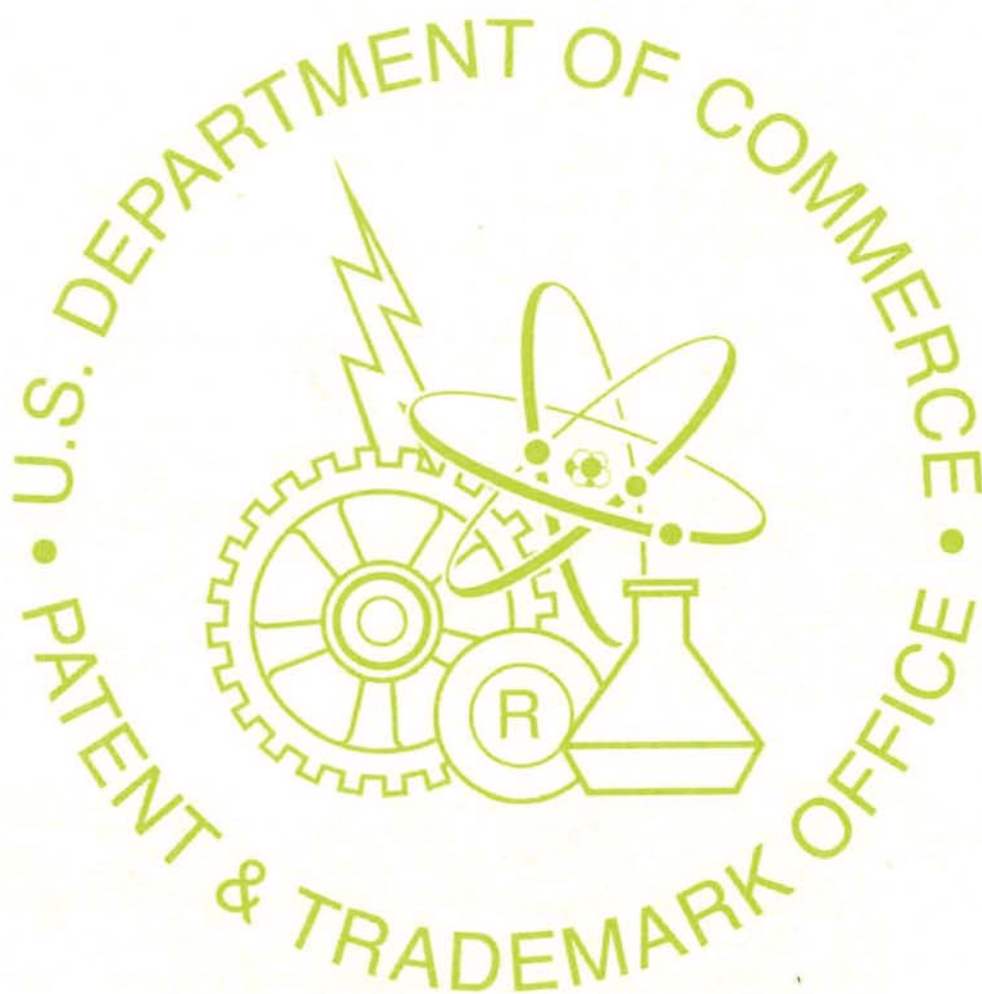
61

10. An electronic watch comprising:  
a display;  
a housing at least partially enclosing the display;  
a front cover positioned over the display and defining at  
least a portion of a front exterior surface of the elec- 5  
tronic watch;  
a biosensor module defining at least a portion of a rear  
exterior surface of the electronic watch opposite the  
front exterior surface, the biosensor module compris- 10  
ing:  
a rear cover defining an optically transparent window;  
an optical sensor positioned below the optically trans-  
parent window;  
a first electrode positioned along the rear exterior 15  
surface of the electronic watch; and  
a second electrode positioned along the rear exterior  
surface of the electronic watch; and  
a third electrode positioned along a side of the electronic  
watch, wherein:  
the electronic watch is configured to measure a first 20  
physiological parameter of a wearer using the optical  
sensor; and  
the electronic watch is configured to measure a second  
physiological parameter using the first electrode, the 25  
second electrode, and the third electrode.  
11. The electronic watch of claim 10, wherein the rear  
cover defines a convex exterior surface.  
12. The electronic watch of claim 11, wherein the opti-  
cally transparent window is located within a portion of the 30  
rear cover that defines the convex exterior surface.  
13. The electronic watch of claim 10, wherein the first  
electrode, the second electrode, and the third electrode are  
part of an electrocardiograph sensing system.  
14. The electronic watch of claim 10, wherein the first 35  
physiological parameter is a heart rate.  
15. The electronic watch of claim 10, wherein the rear  
cover comprises sapphire.  
16. A wearable electronic device comprising:  
a housing;  
a band attached to the housing and configured to couple 40  
the wearable electronic device to a user;

62

a touch-sensitive display positioned at least partially  
within the housing;  
a rear cover positioned at least partially within a rear  
opening defined along a rear portion of the housing, the  
rear cover defining at least a portion of a rear exterior  
surface of the wearable electronic device and having an  
optically transparent portion;  
an optical sensor positioned within the housing and con-  
figured to emit an optical signal through the optically  
transparent portion;  
a first electrode positioned along the rear exterior surface  
of the wearable electronic device;  
a second electrode positioned along the rear exterior  
surface of the wearable electronic device; and  
a third electrode positioned along a side of the wearable  
electronic device, wherein:  
the wearable electronic device is configured to measure  
a first physiological parameter using the optical  
sensor; and  
the wearable electronic device is configured to measure  
a second physiological parameter using the first  
electrode, the second electrode, and the third elec-  
trode.  
17. The wearable electronic device of claim 16, wherein:  
the first electrode, the second electrode, and the third  
electrode are part of an electrocardiograph sensing  
system; and  
the second physiological parameter is an electrocardio-  
gram.  
18. The wearable electronic device of claim 16, further  
comprising an input device positioned along a side of the  
housing and configured to receive at least one of a rotational  
input or a translational input.  
19. The wearable electronic device of claim 16, wherein  
the rear cover defines a convex exterior surface.  
20. The wearable electronic device of claim 16, wherein  
the optical sensor comprises:  
an optical emitter configured to emit the optical signal  
through the optically transparent portion; and  
an optical receiver configured to receive a reflected por-  
tion of the optical signal through the rear cover.

\* \* \* \* \*





# **EXHIBIT 11**



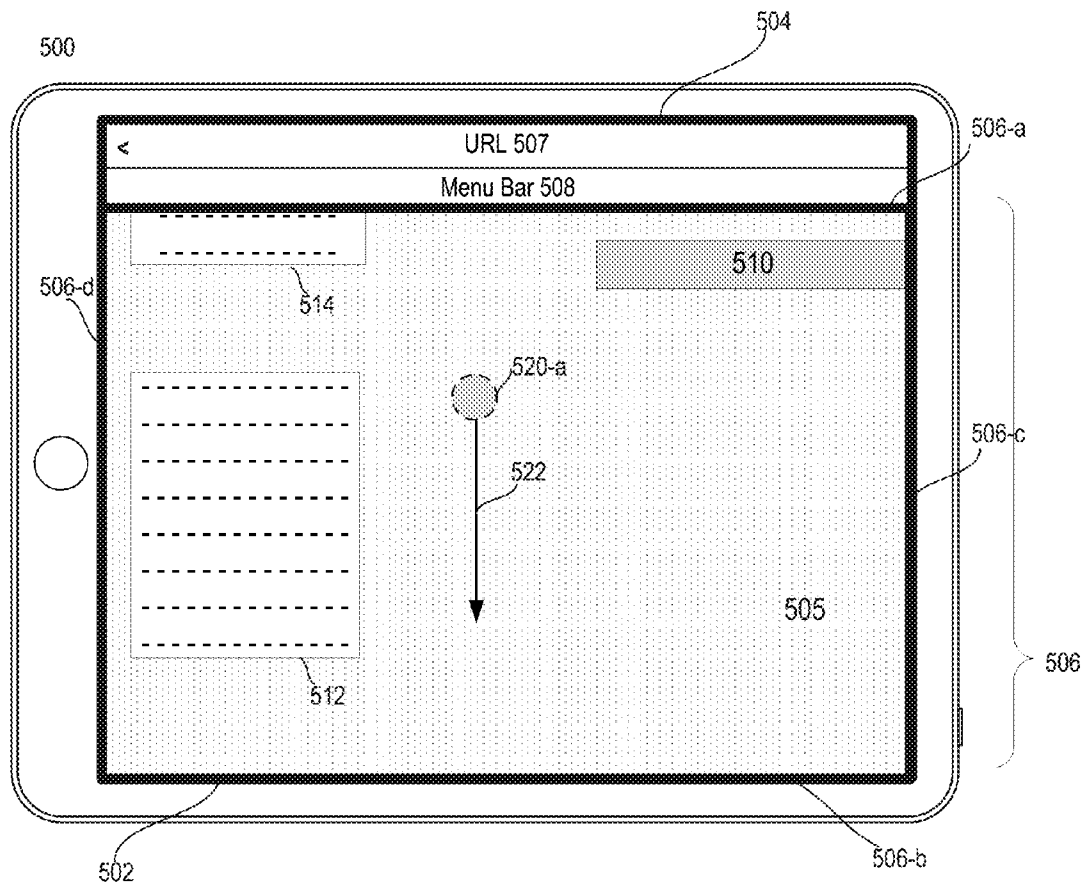
US 20160202865A1

(19) **United States**(12) **Patent Application Publication**  
**DAKIN et al.**(10) **Pub. No.: US 2016/0202865 A1**(43) **Pub. Date: Jul. 14, 2016**(54) **COORDINATION OF STATIC  
BACKGROUNDS AND RUBBERBANDING****G06T 3/20** (2006.01)**G06F 3/0488** (2006.01)(71) Applicant: **Apple Inc.**, Cupertino, CA (US)(52) **U.S. Cl.**CPC ..... **G06F 3/0485** (2013.01); **G06F 3/04883**  
(2013.01); **G06F 3/0481** (2013.01); **G06T 3/20**  
(2013.01)(72) Inventors: **Beth DAKIN**, San Jose, CA (US);  
**Jonathan LEE**, San Francisco, CA  
(US); **Simon M. FRASER**, Sunnyvale,  
CA (US)

(57)

**ABSTRACT**(21) Appl. No.: **14/871,816**(22) Filed: **Sep. 30, 2015****Related U.S. Application Data**(60) Provisional application No. 62/101,346, filed on Jan.  
8, 2015.**Publication Classification**(51) **Int. Cl.****G06F 3/0485** (2006.01)**G06F 3/0481** (2006.01)

Techniques for coordinating movements of various objects in an electronic document are disclosed. A first-type object remains stationary so that it becomes outside a content boundary of the electronic document, as the content boundary is pulled inside an edge of a window displaying the electronic document. A second-type object remains stationary until the content boundary reaches the edge of the window and then moves along with the scrolled electronic document as the content boundary is pulled inside the edge of the window. A third-type object and a fourth-type object may show different movement behaviors.



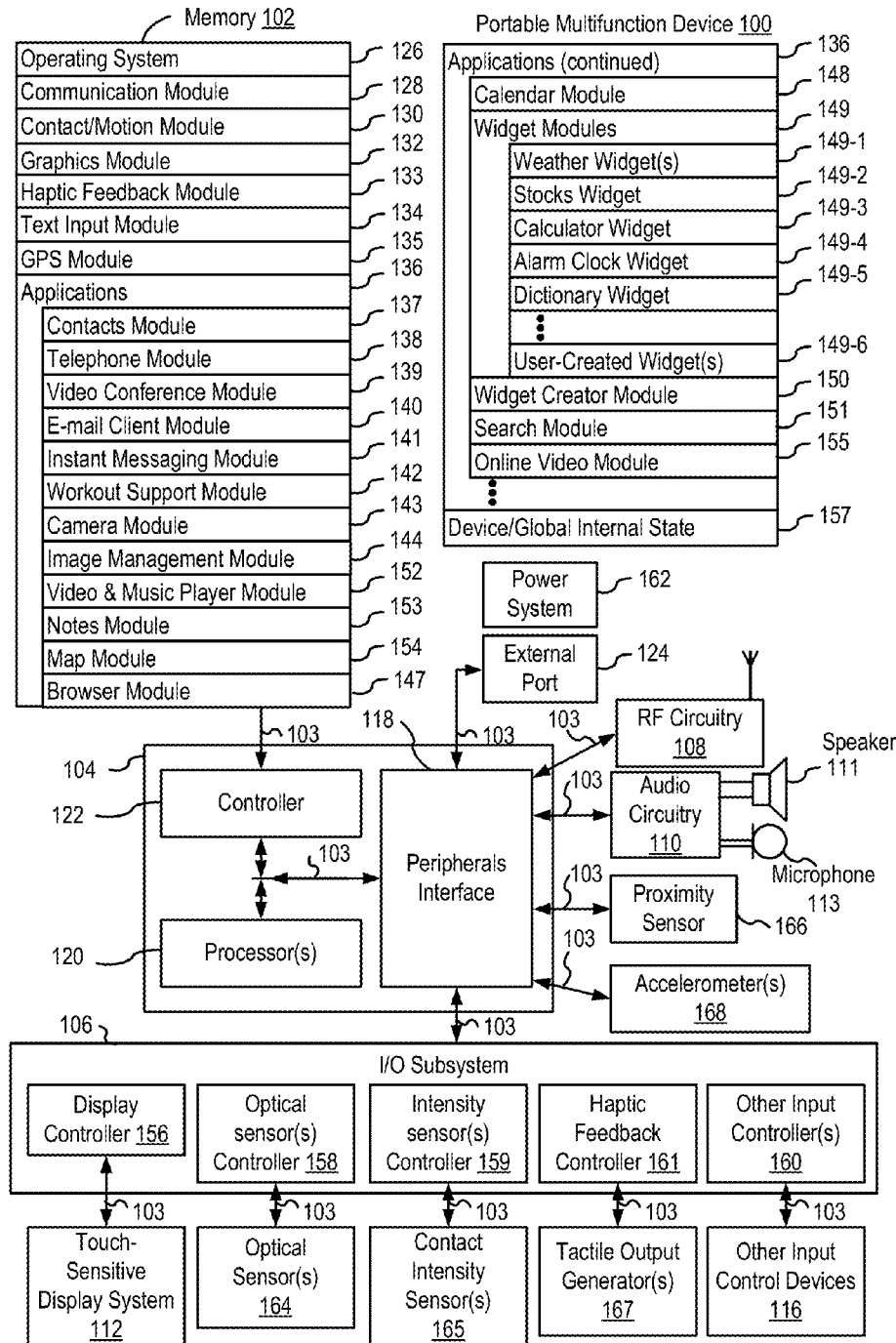


FIG. 1A

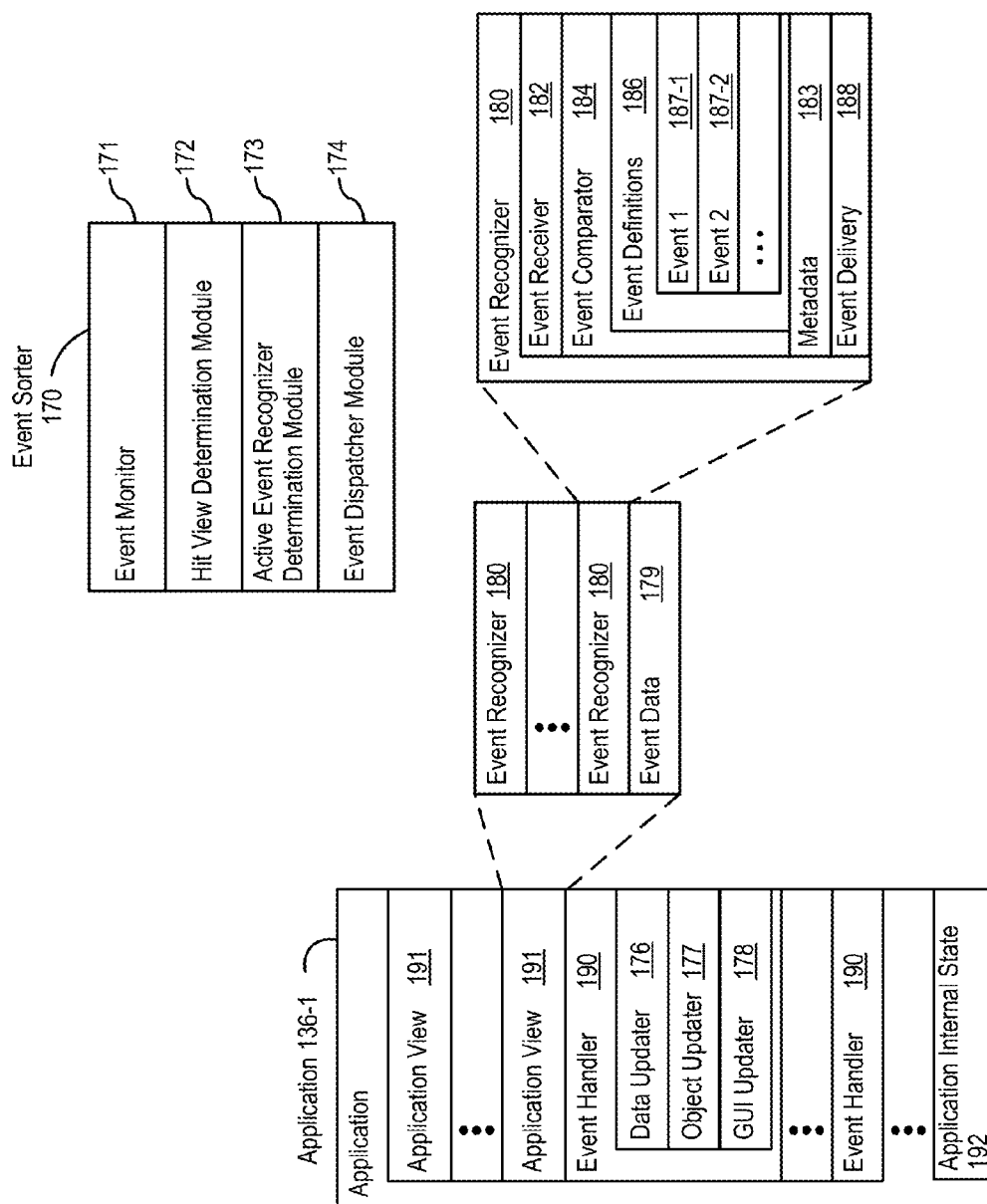


FIG. 1B

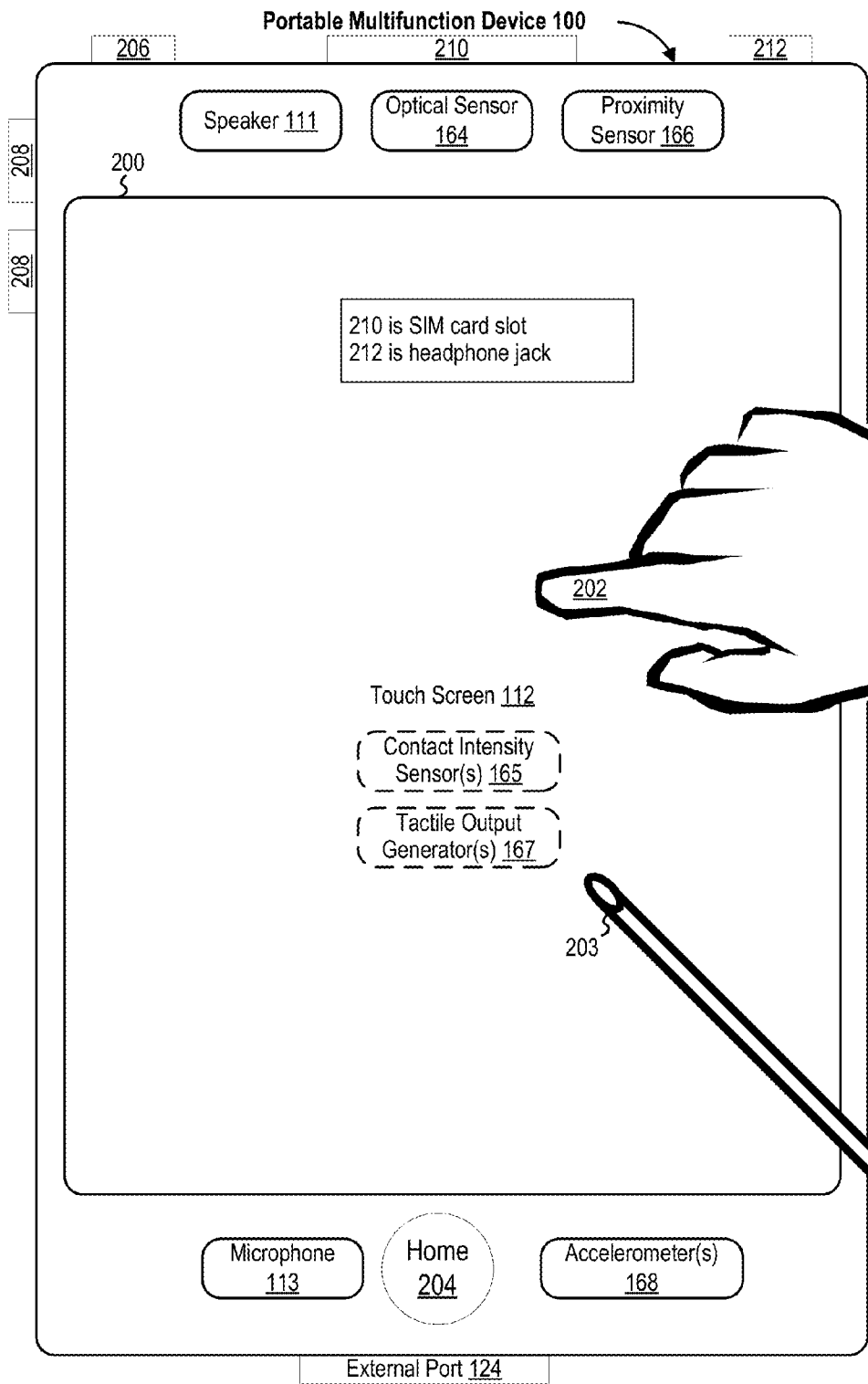


FIG. 2



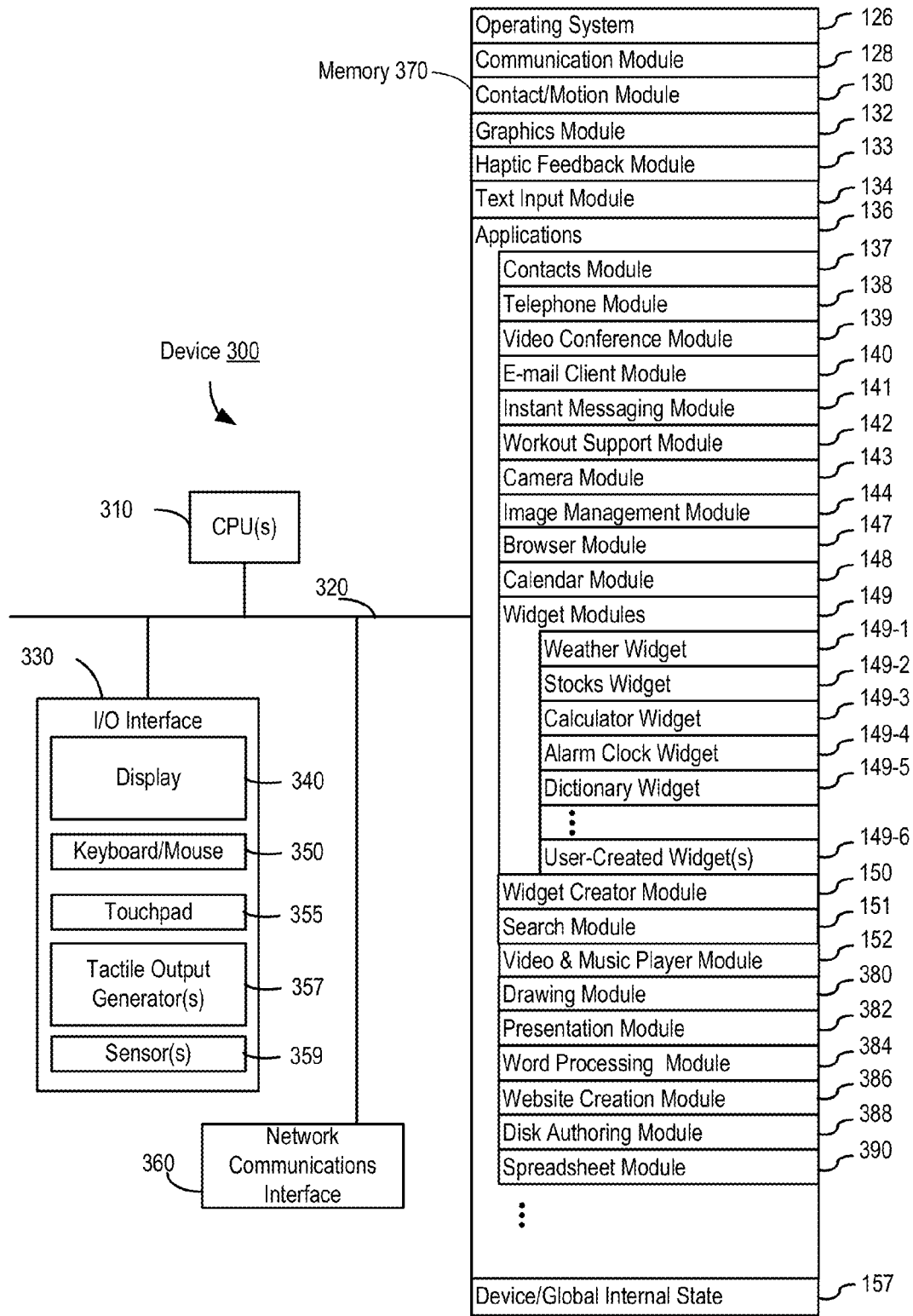


FIG. 3

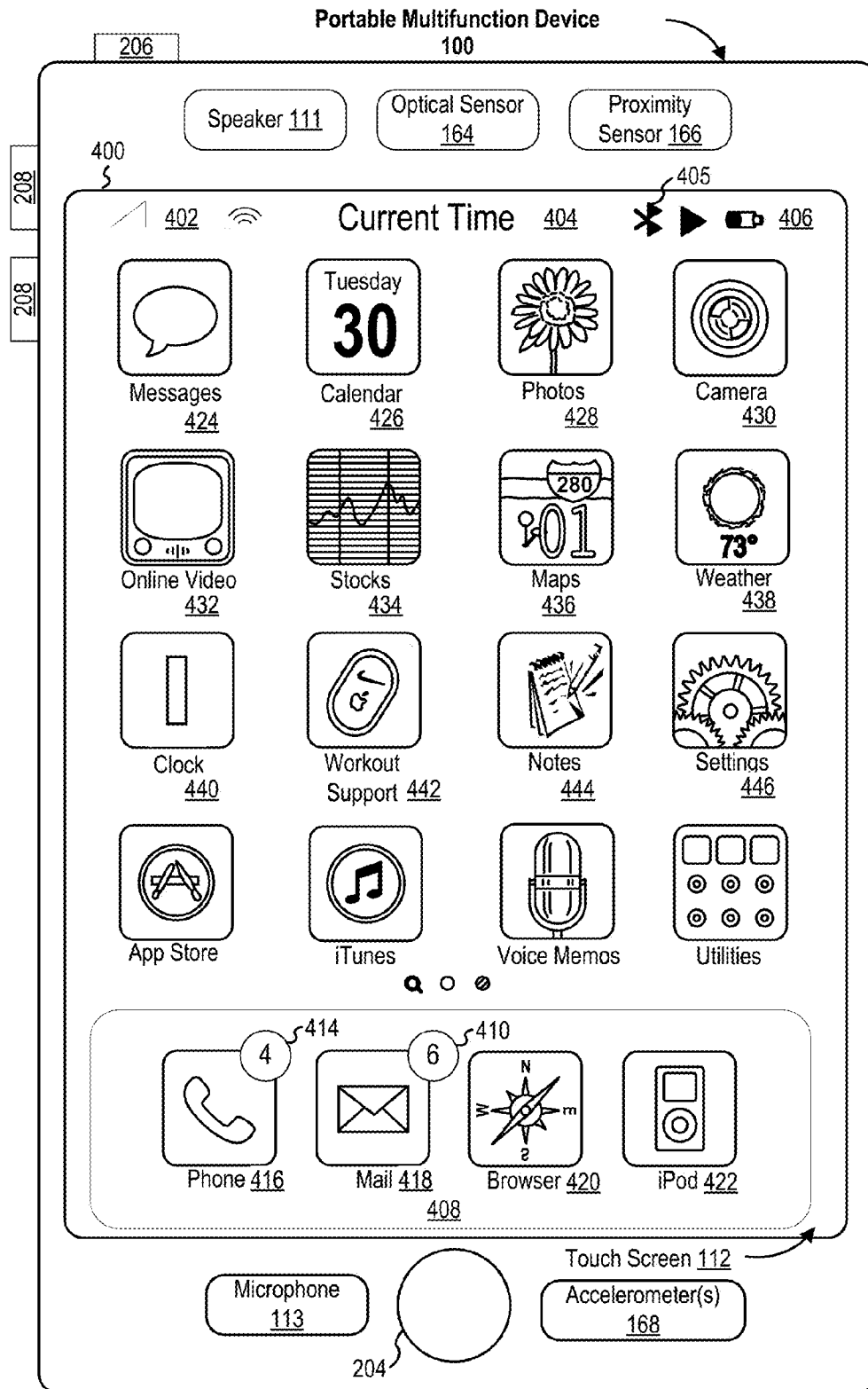


FIG. 4A

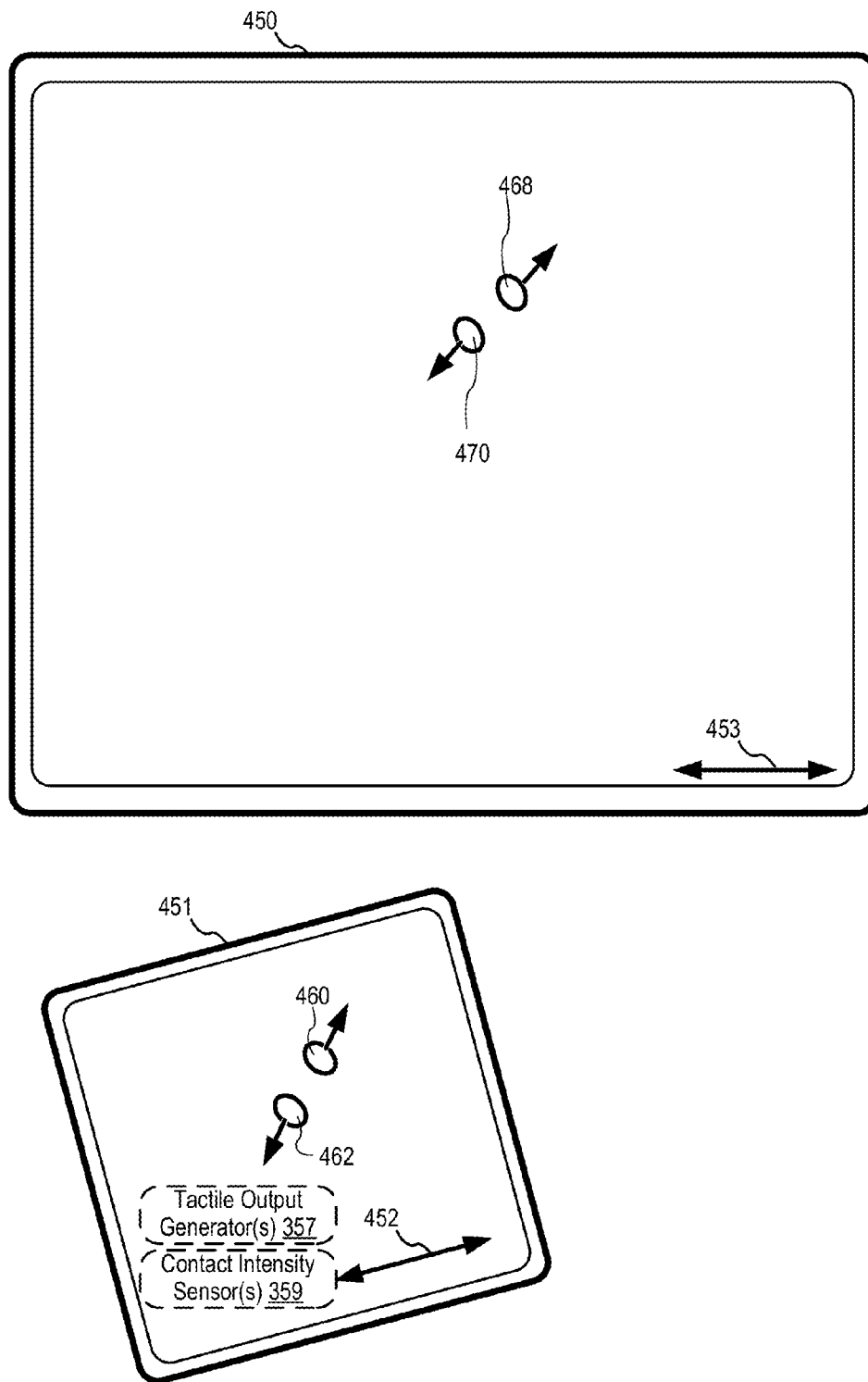


FIG. 4B

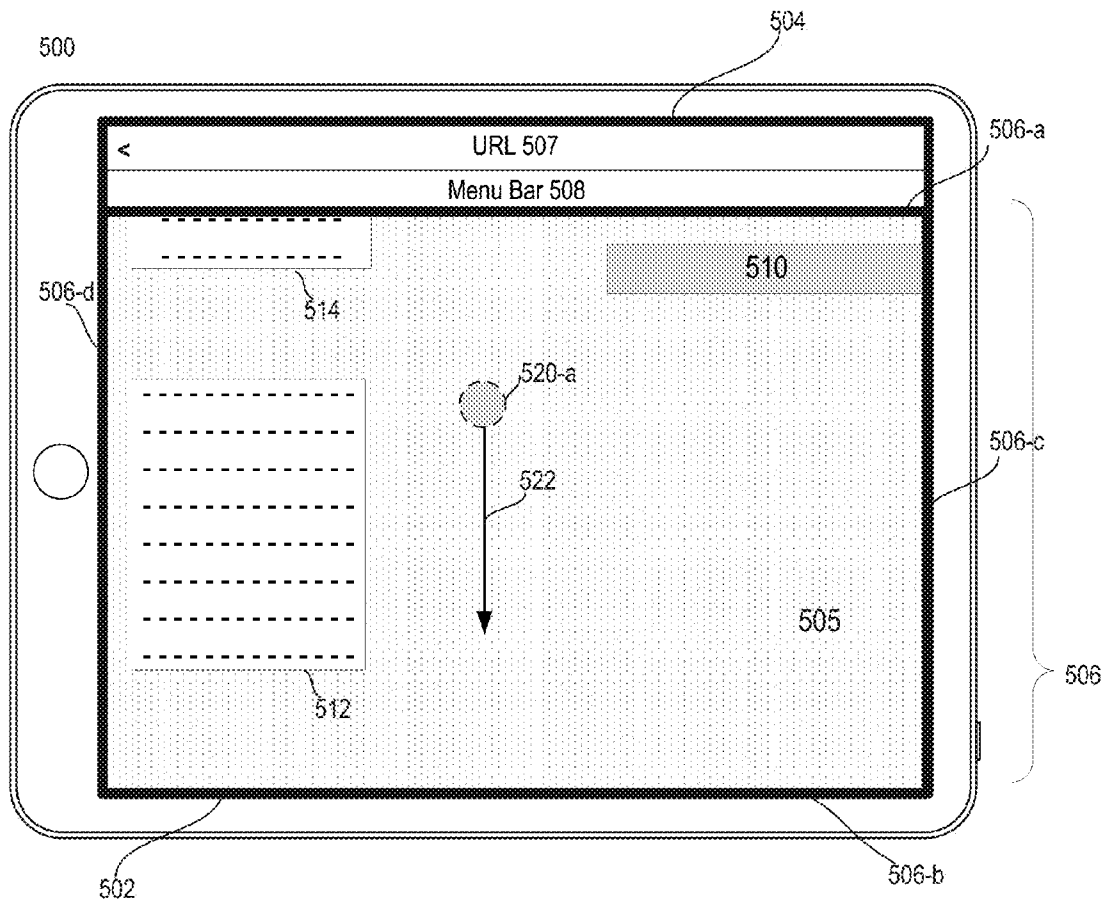


FIG. 5A

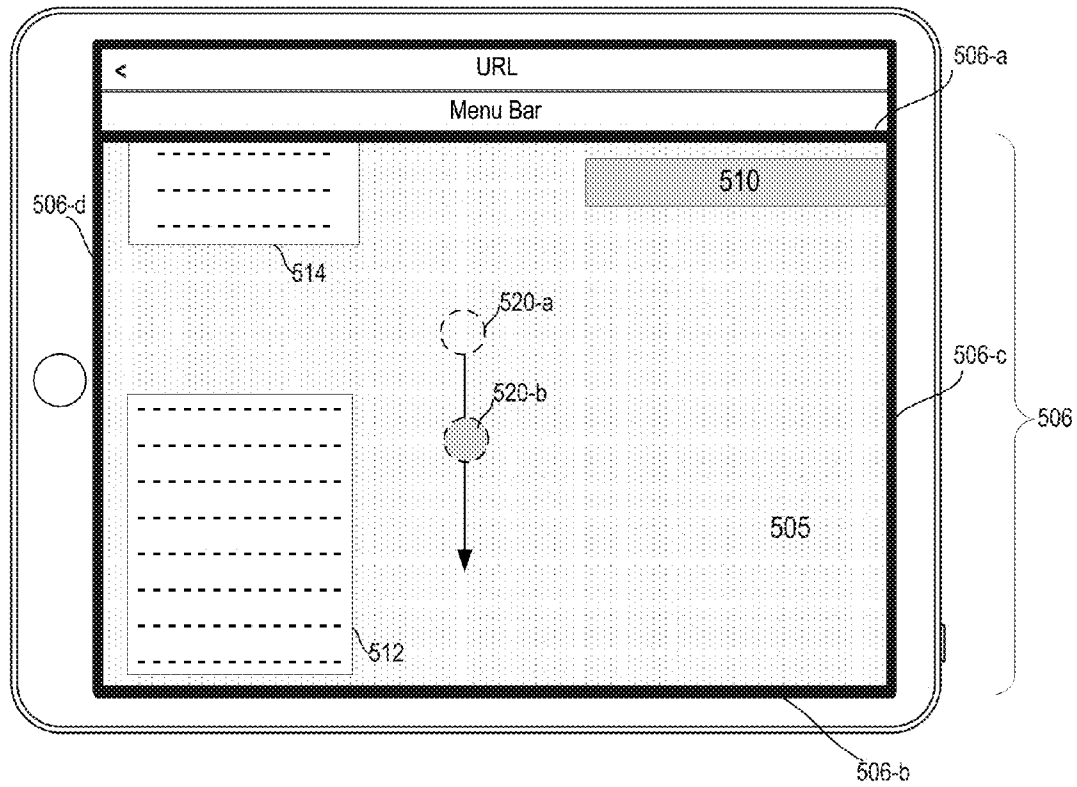


FIG. 5B



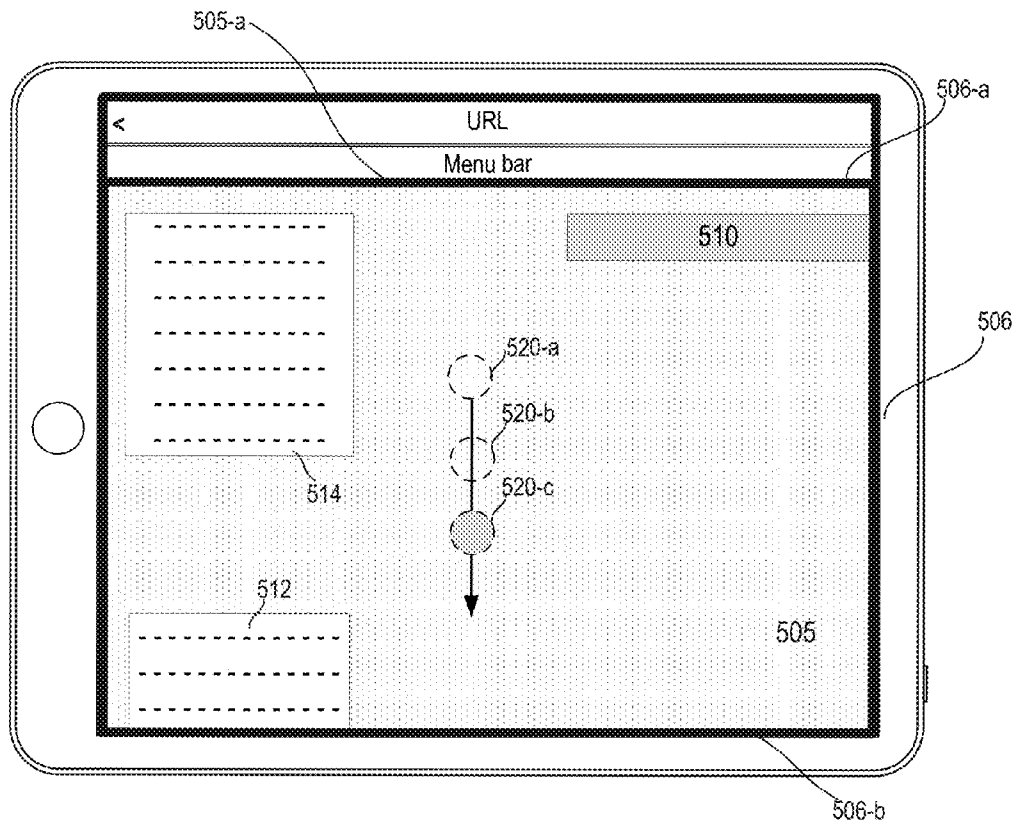


FIG. 5C

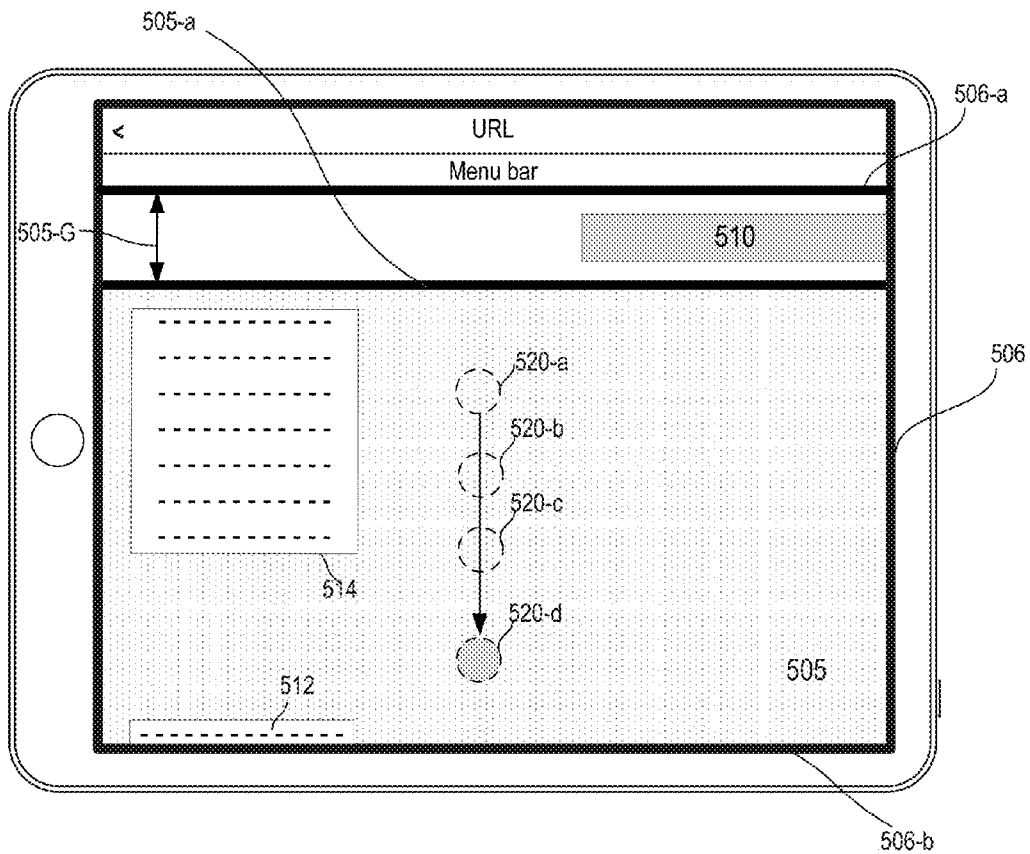


FIG. 5D

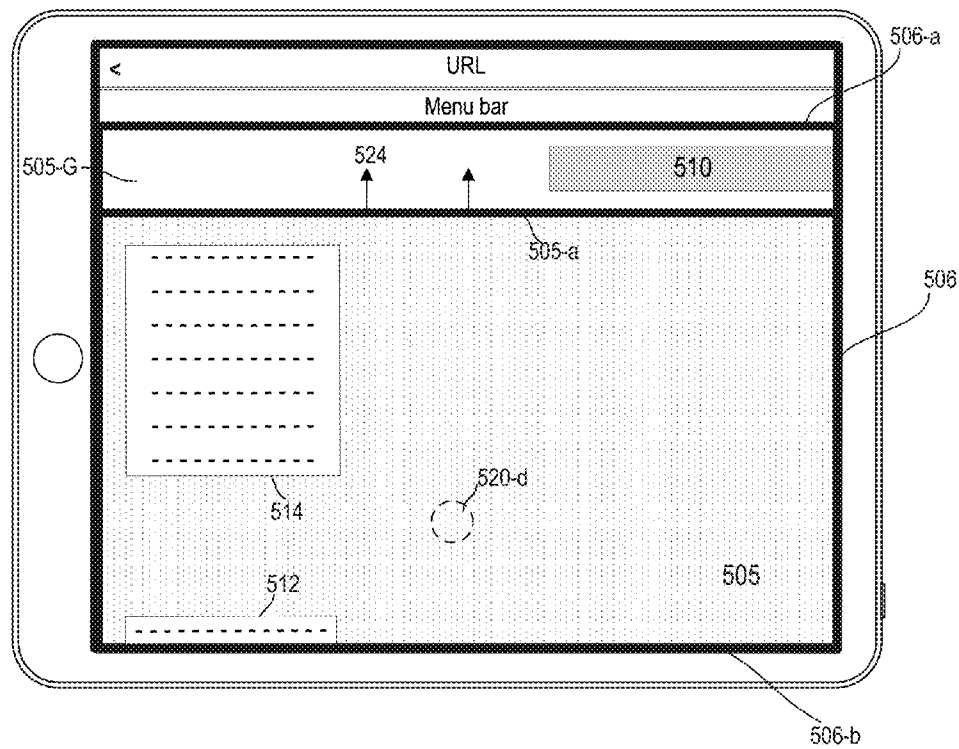


FIG. 5E

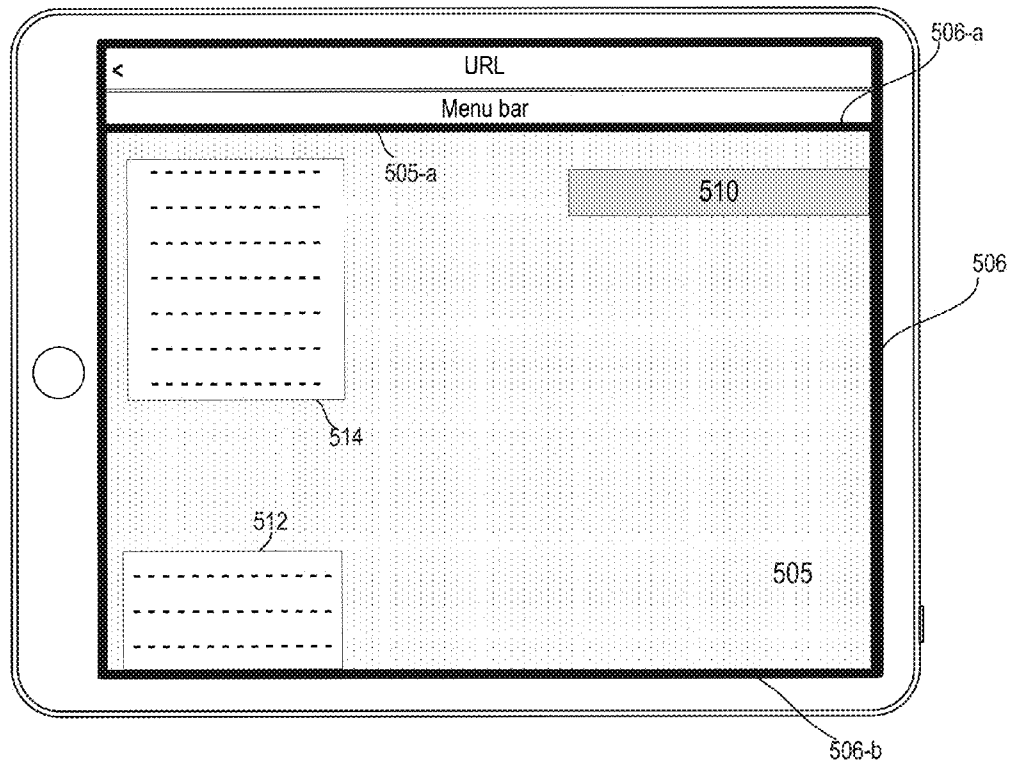


FIG. 5F

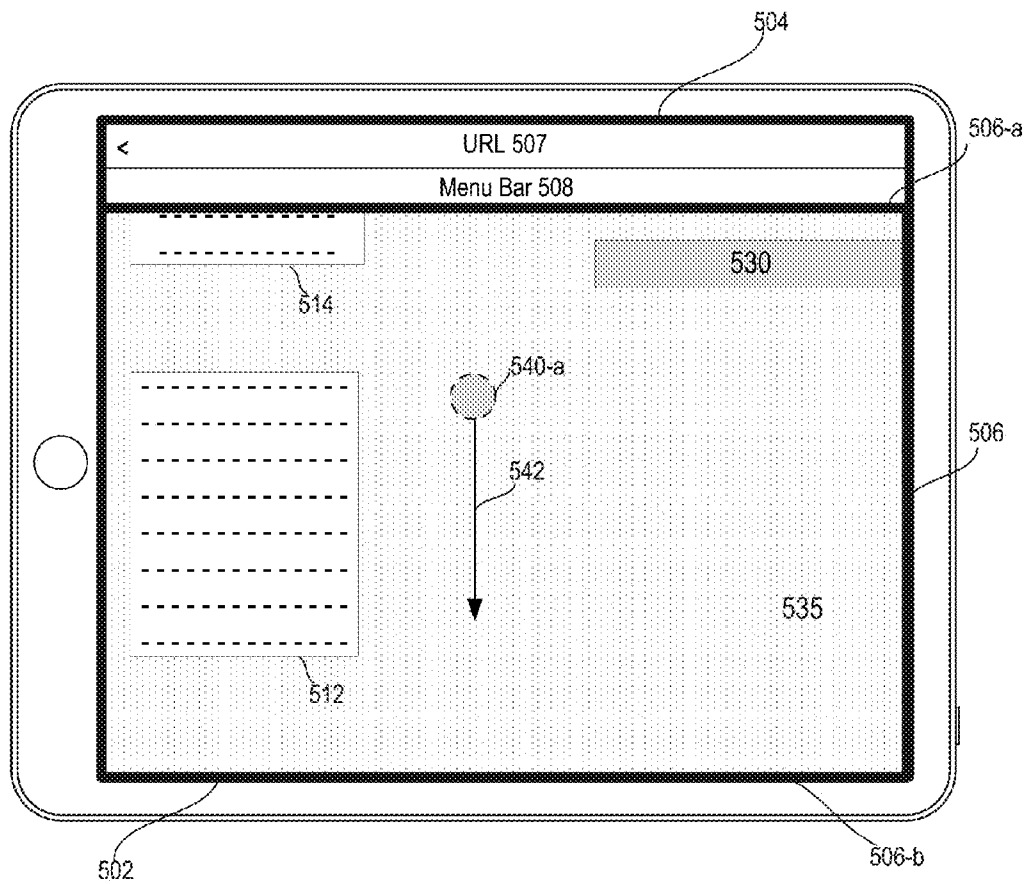


FIG. 5G



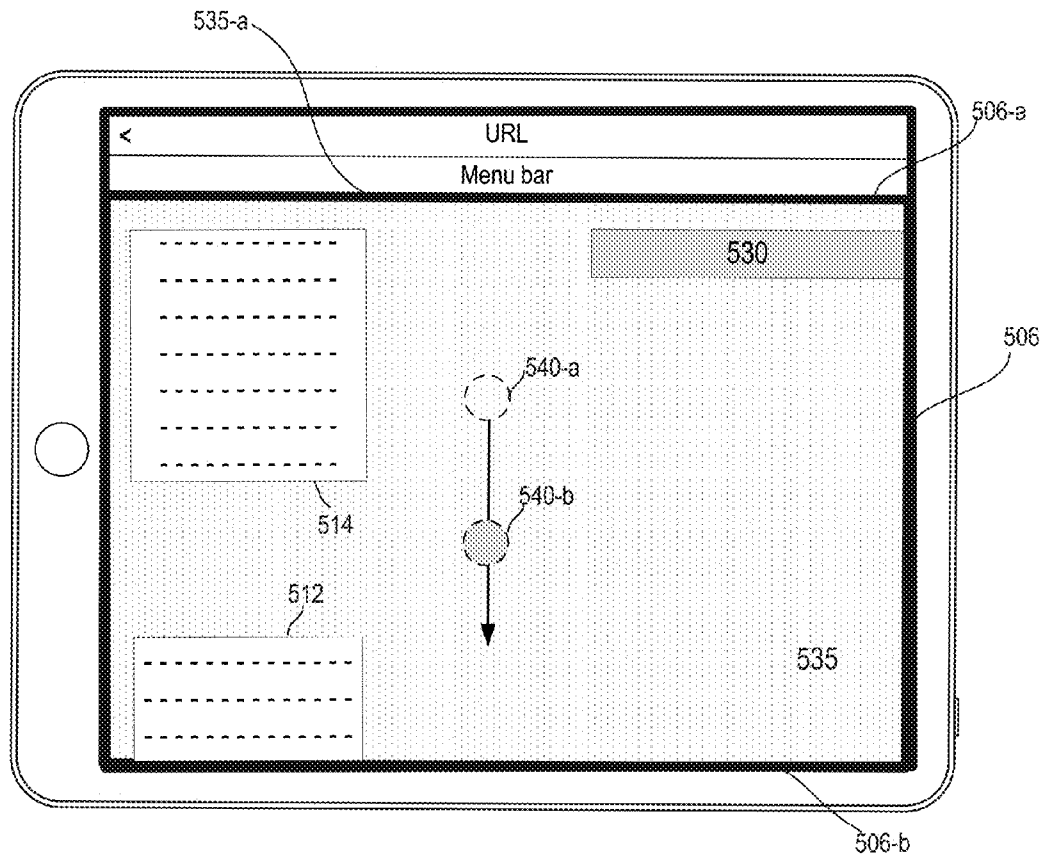


FIG. 5H

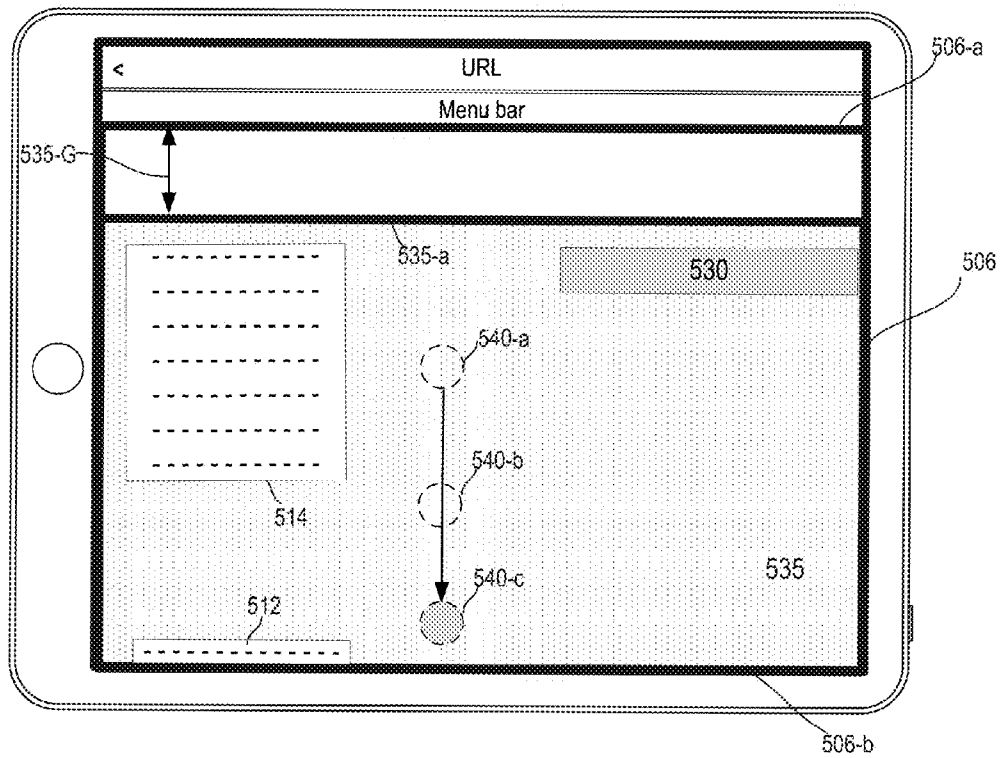


FIG. 5I

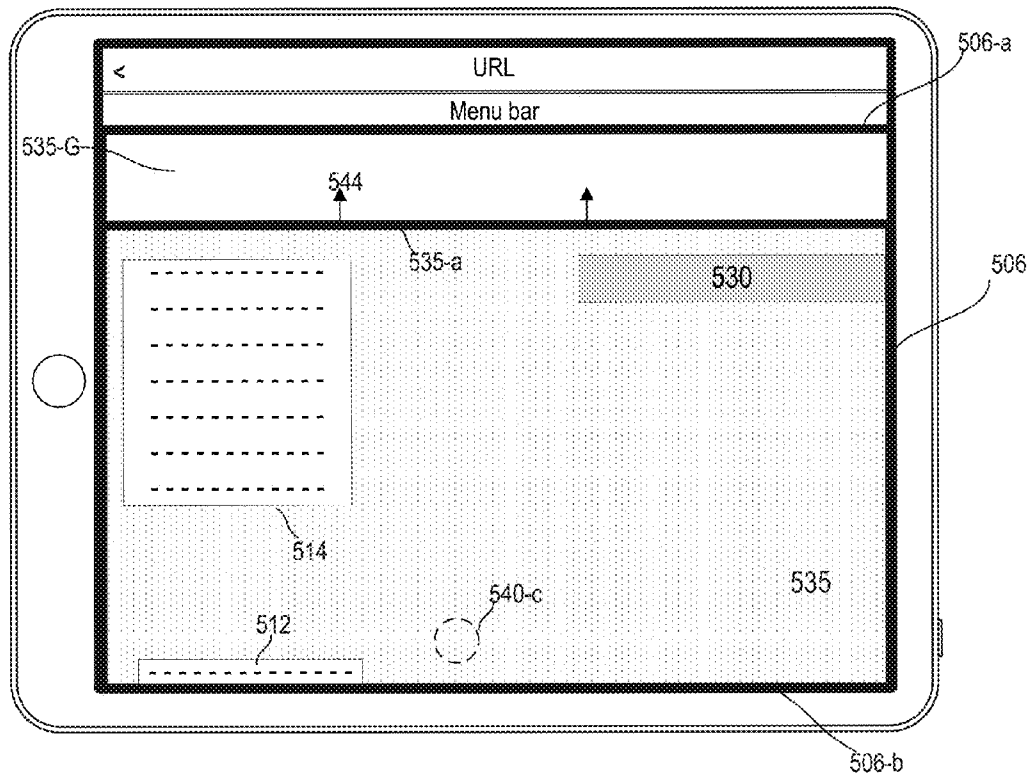


FIG. 5J

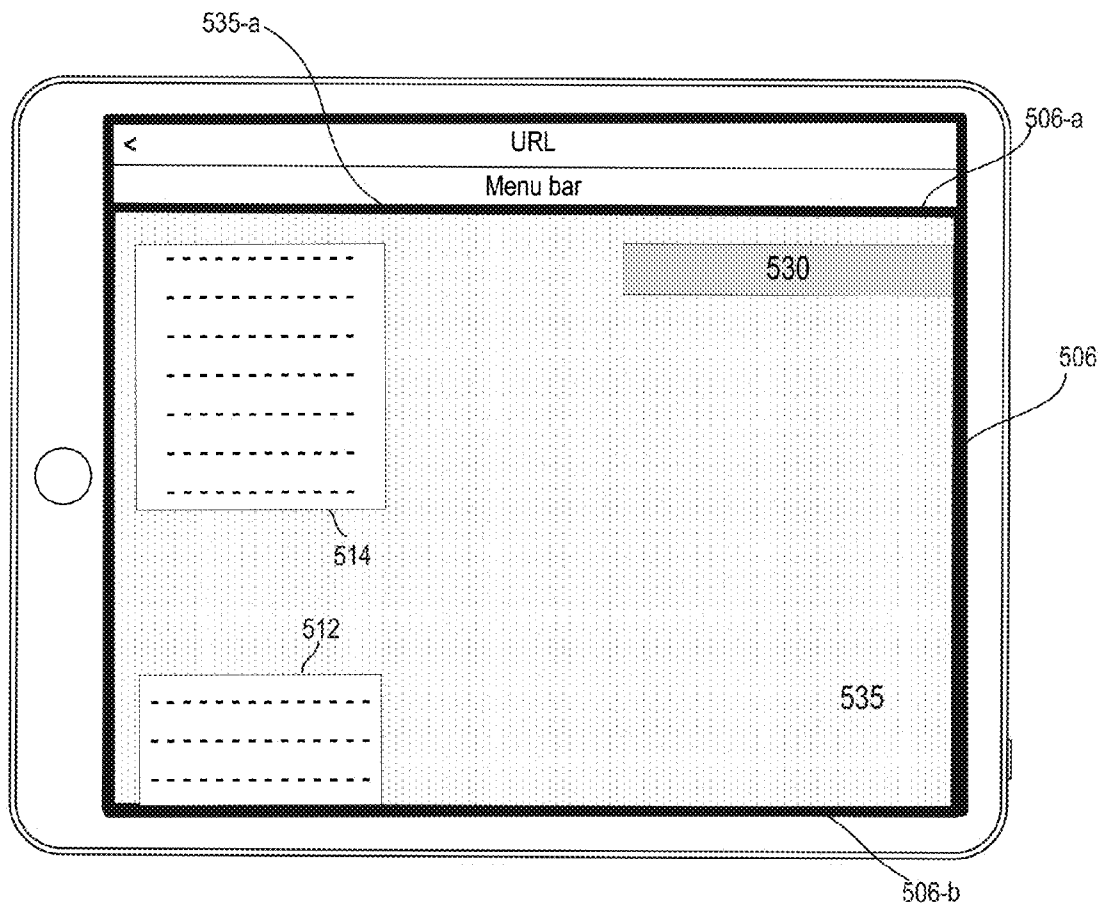


FIG. 5K

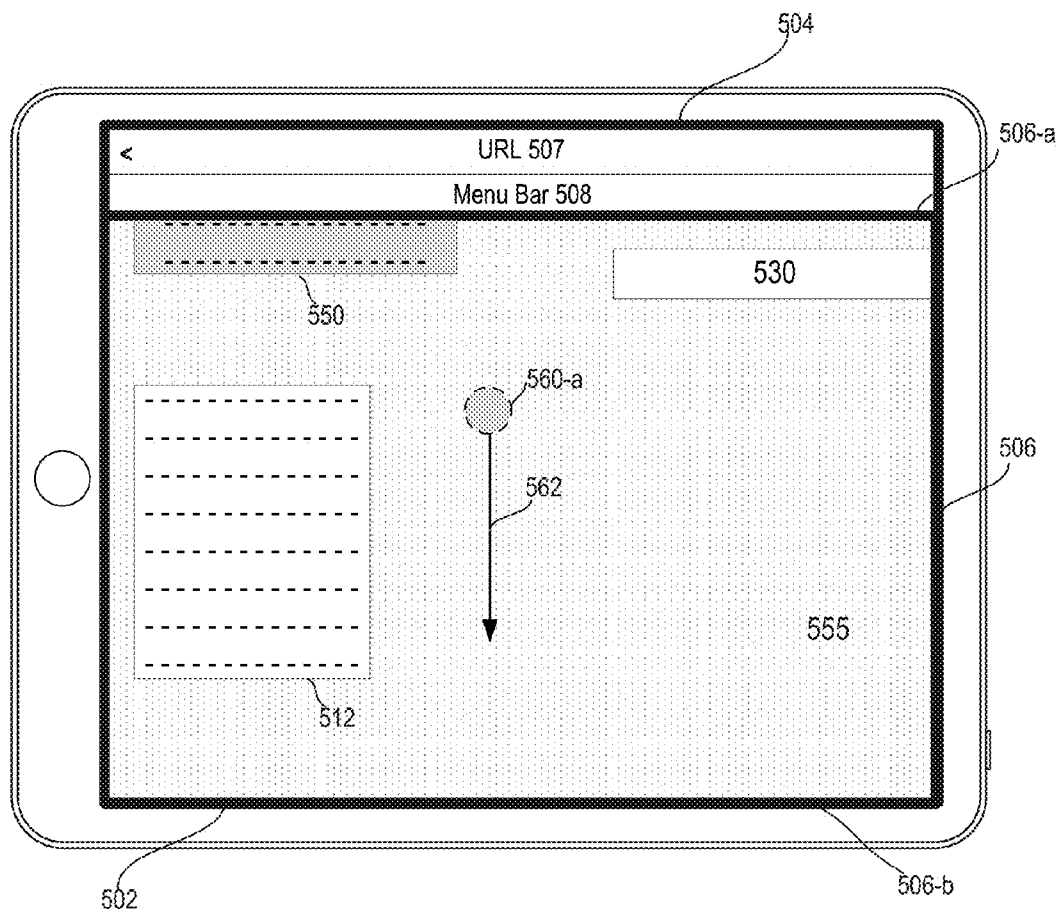


FIG. 5L



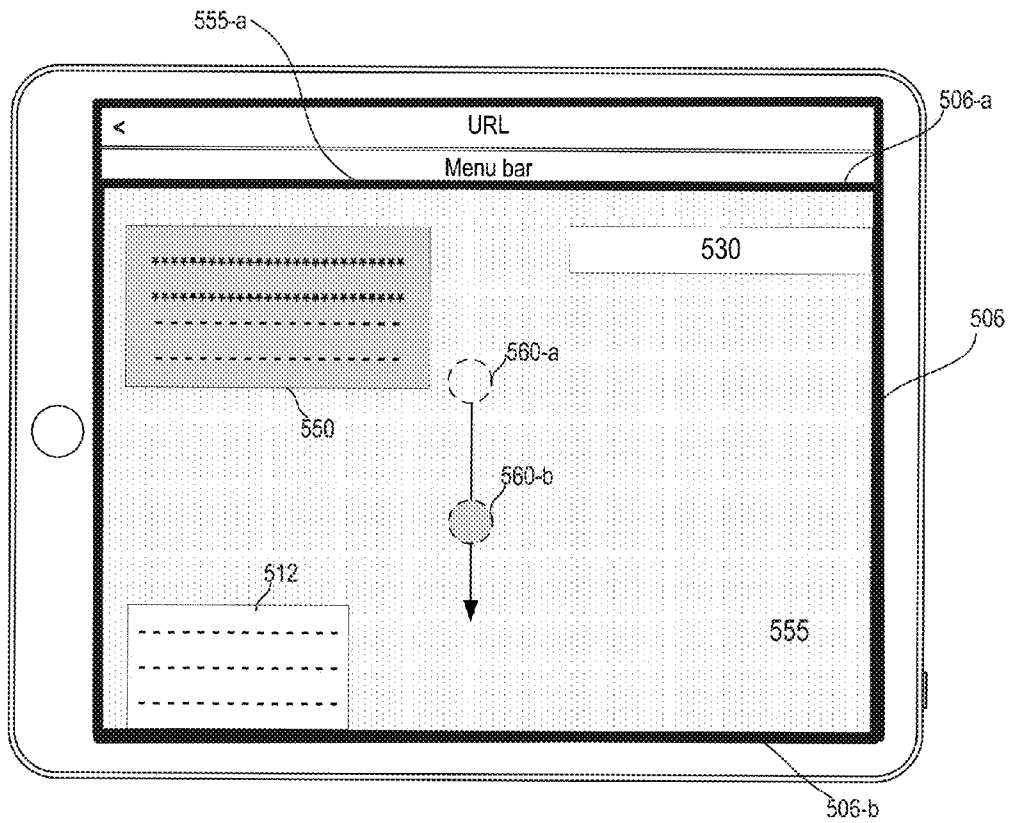


FIG. 5M

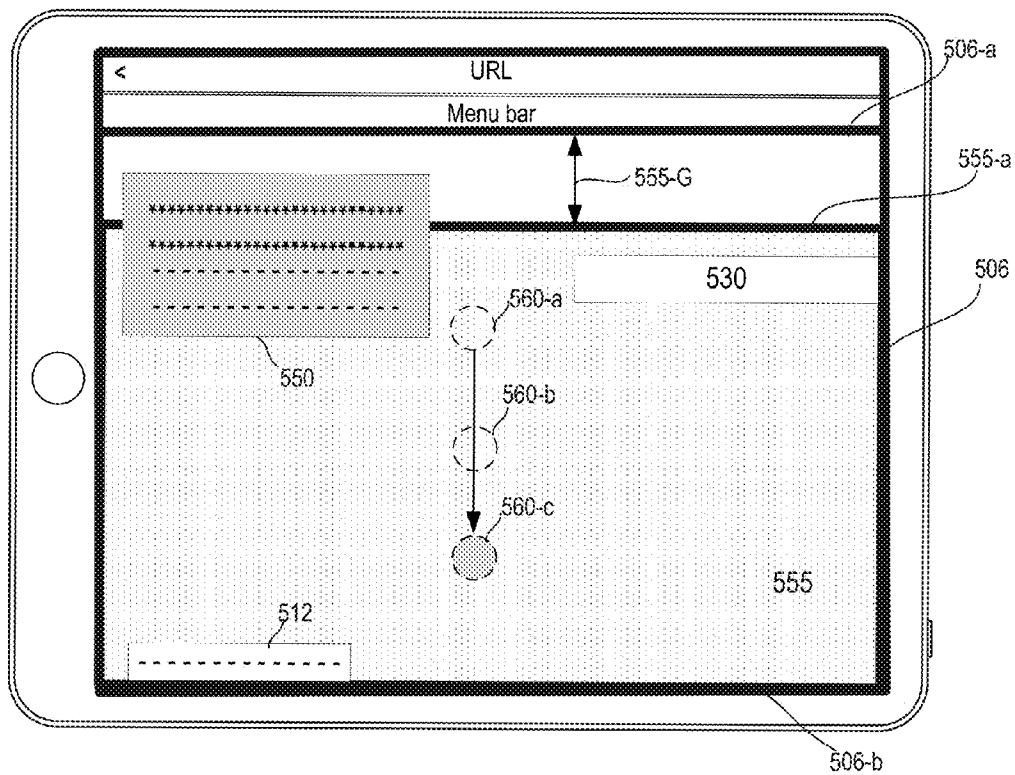


FIG. 5N

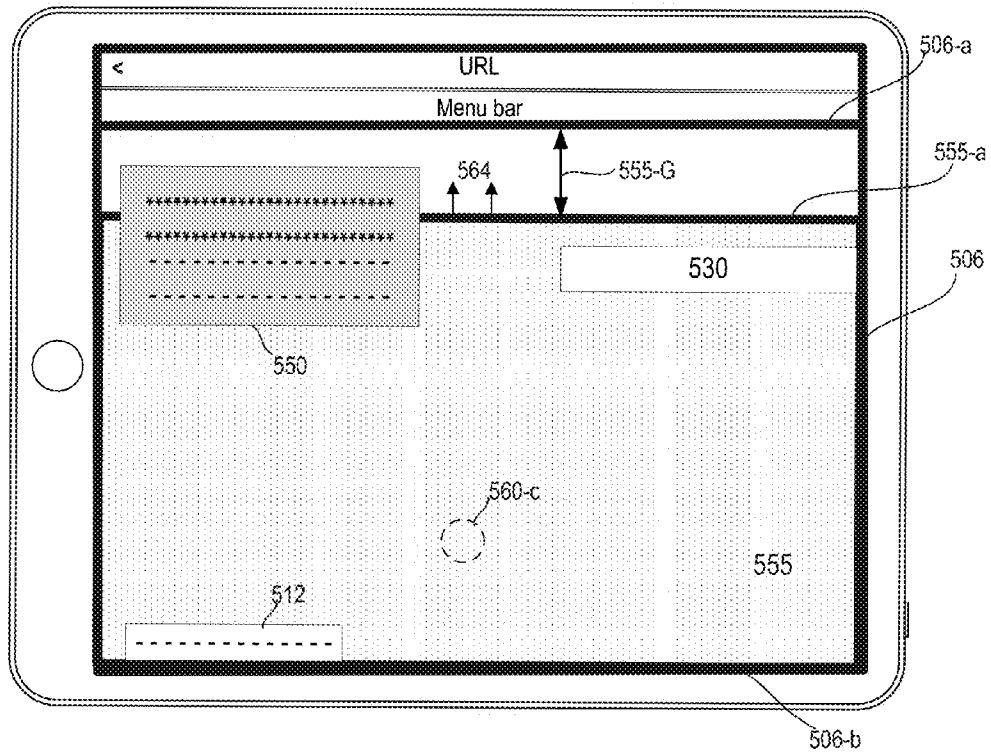


FIG. 50

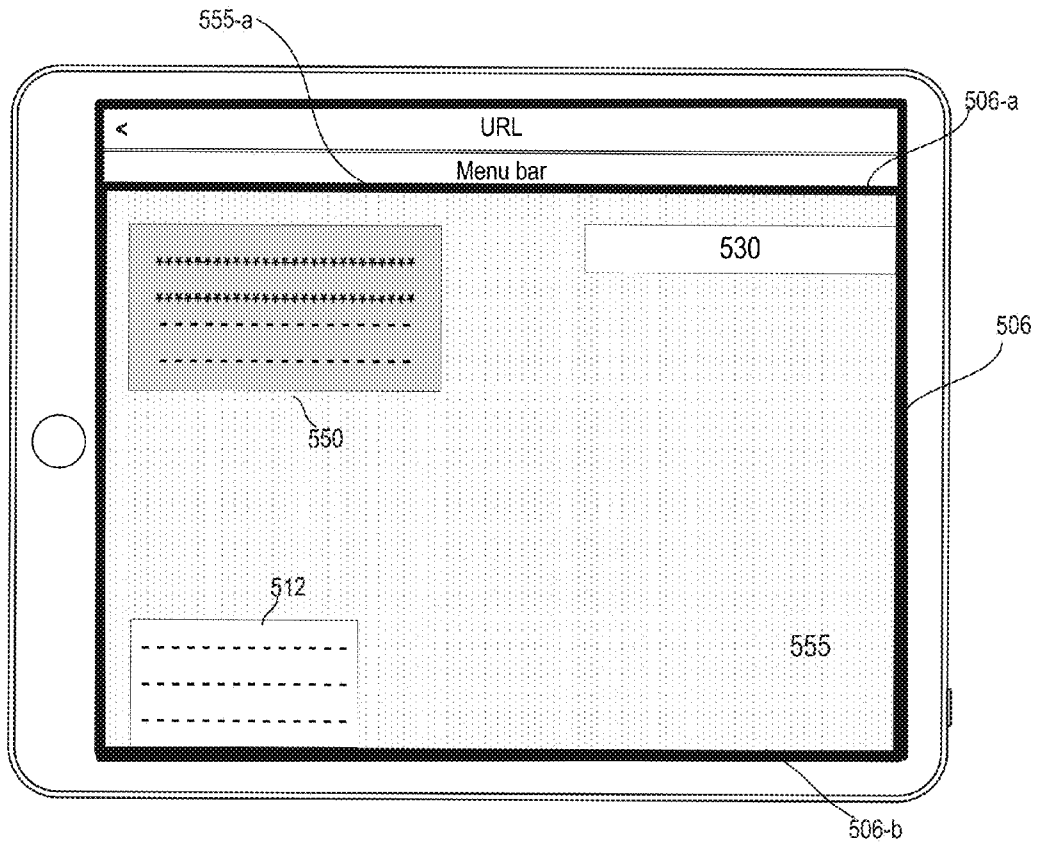


FIG. 5P

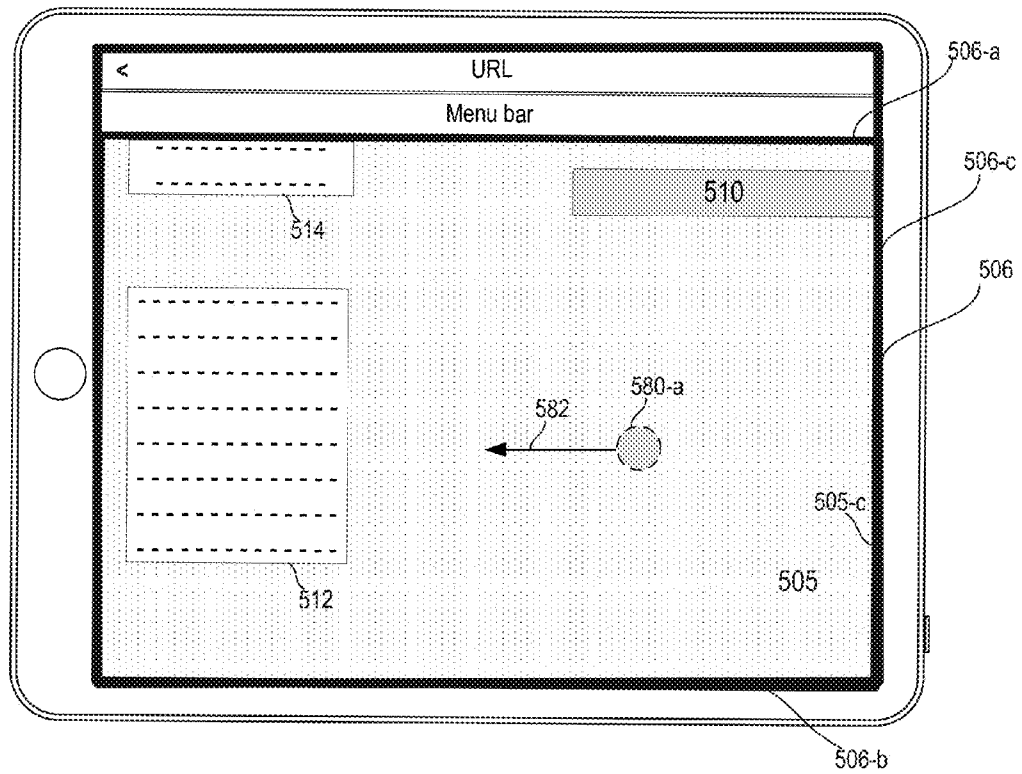


FIG. 5Q



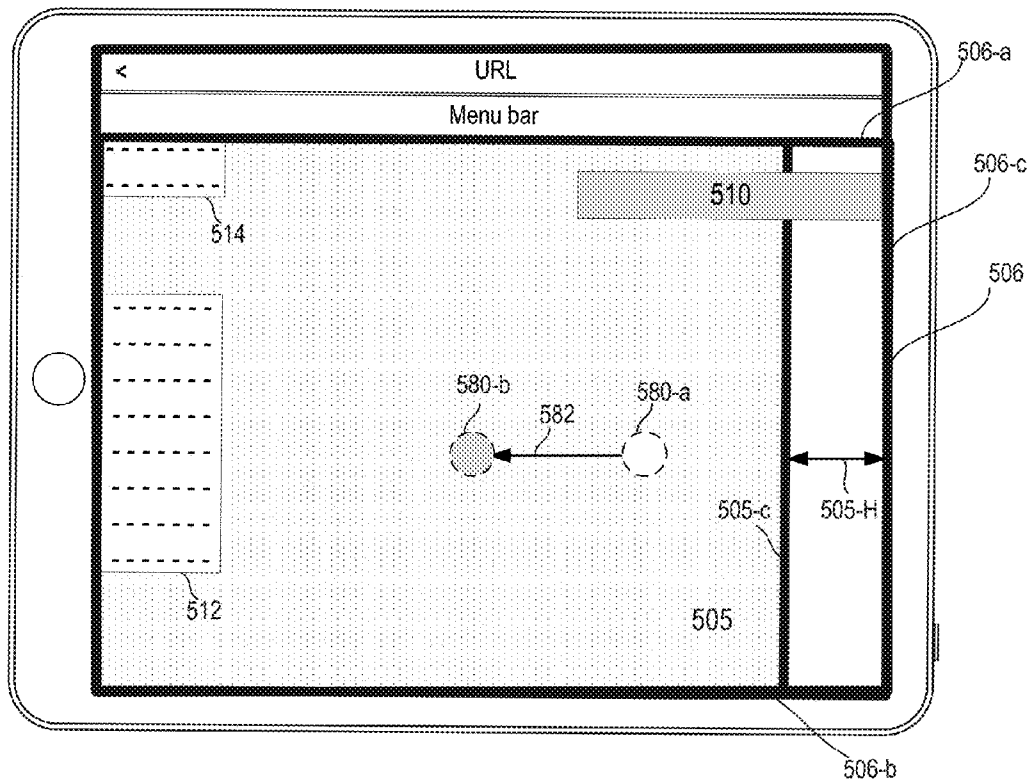


FIG. 5R

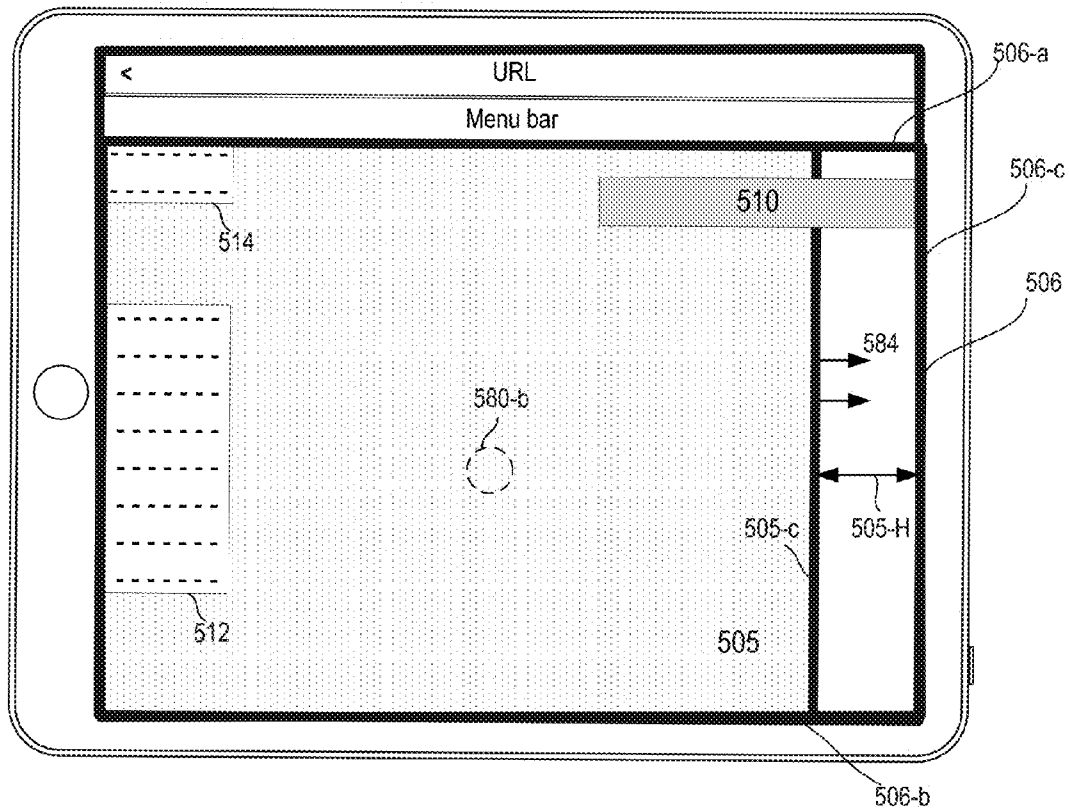


FIG. 5S

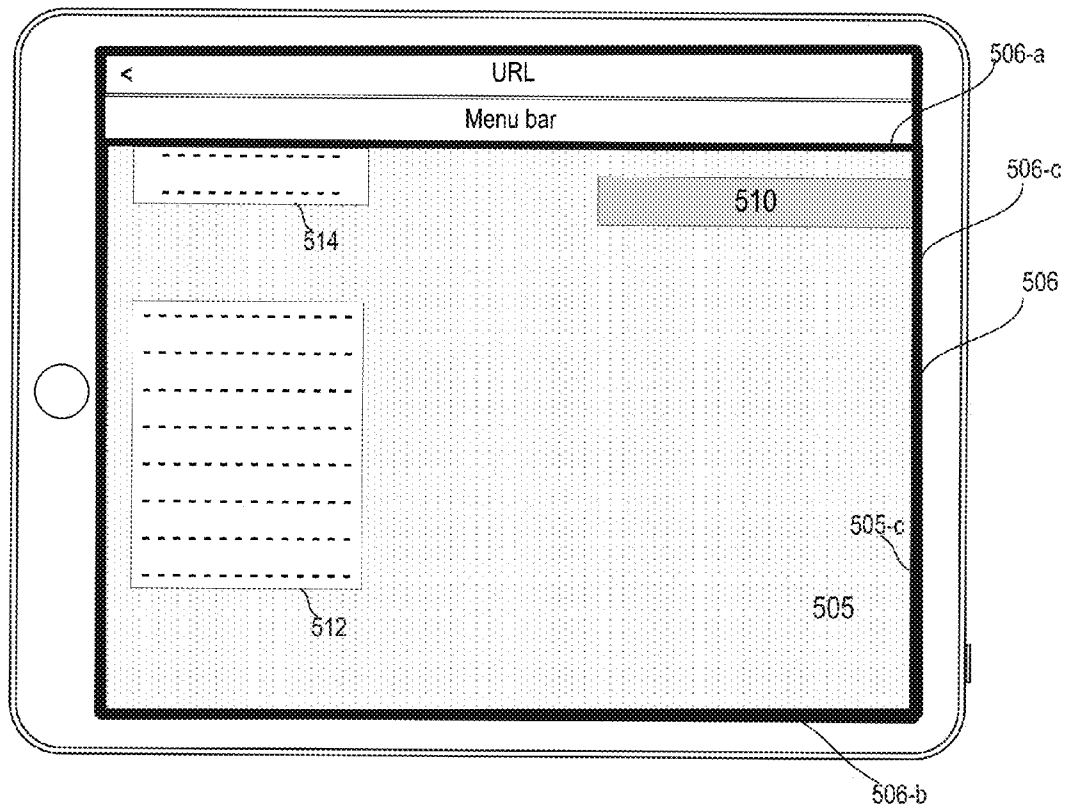


FIG. 5T

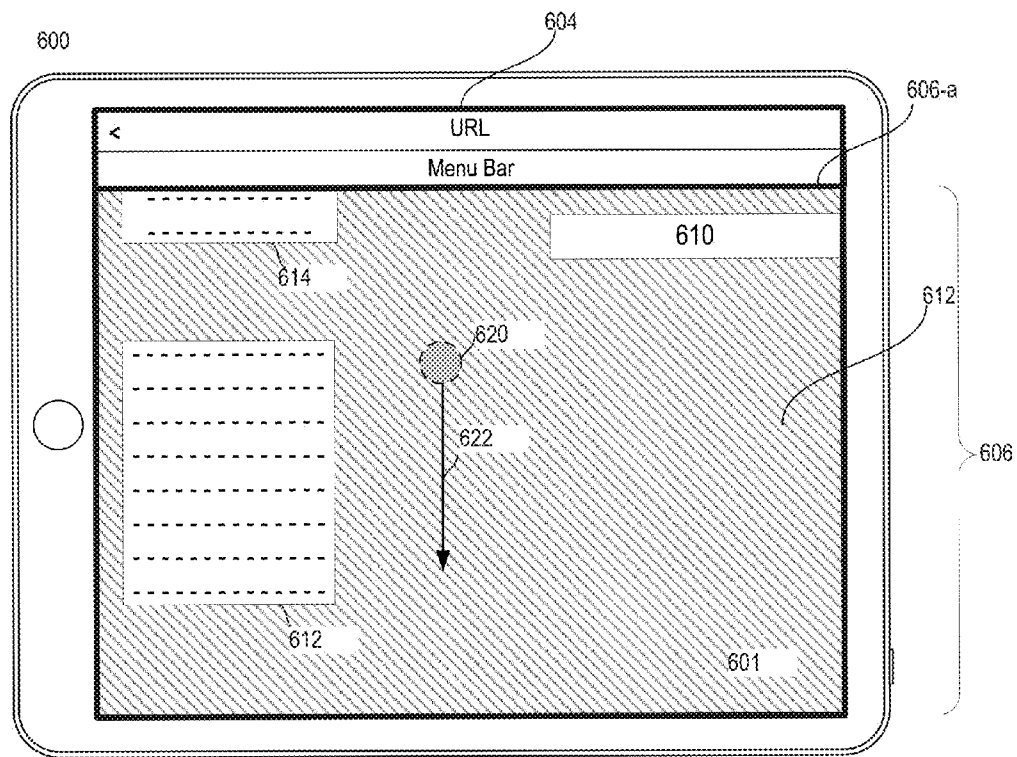


FIG. 6A

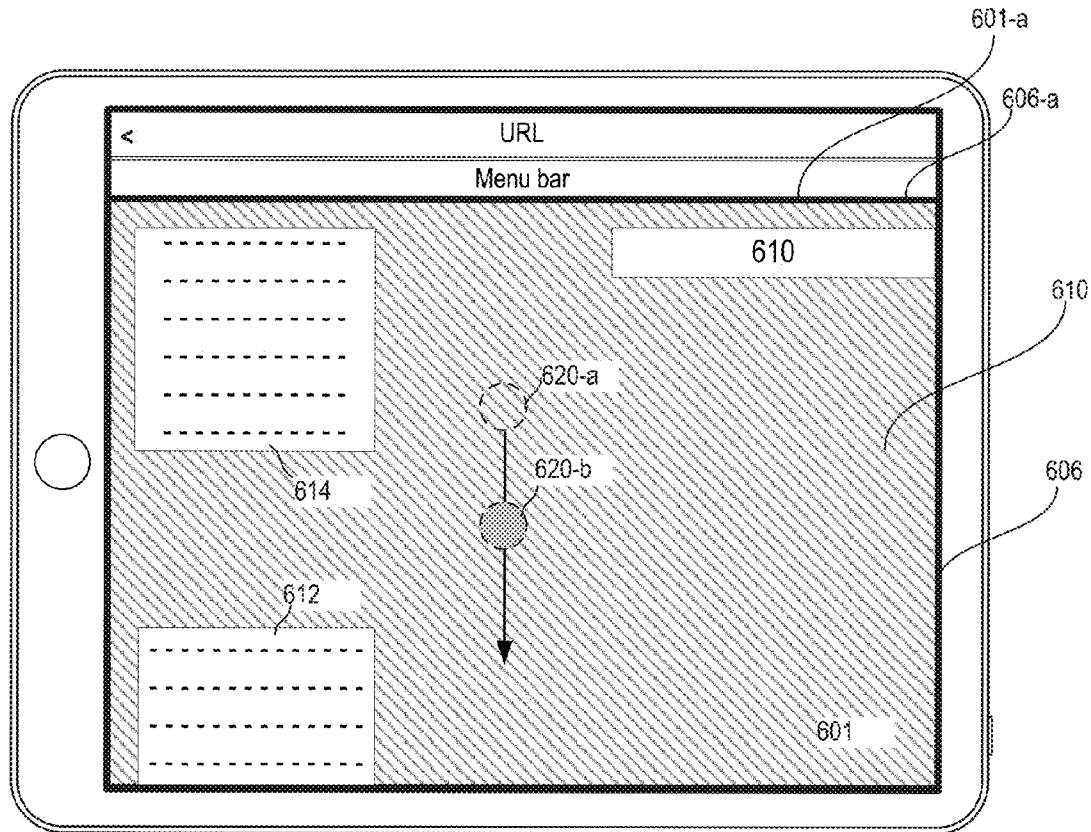


FIG. 6B



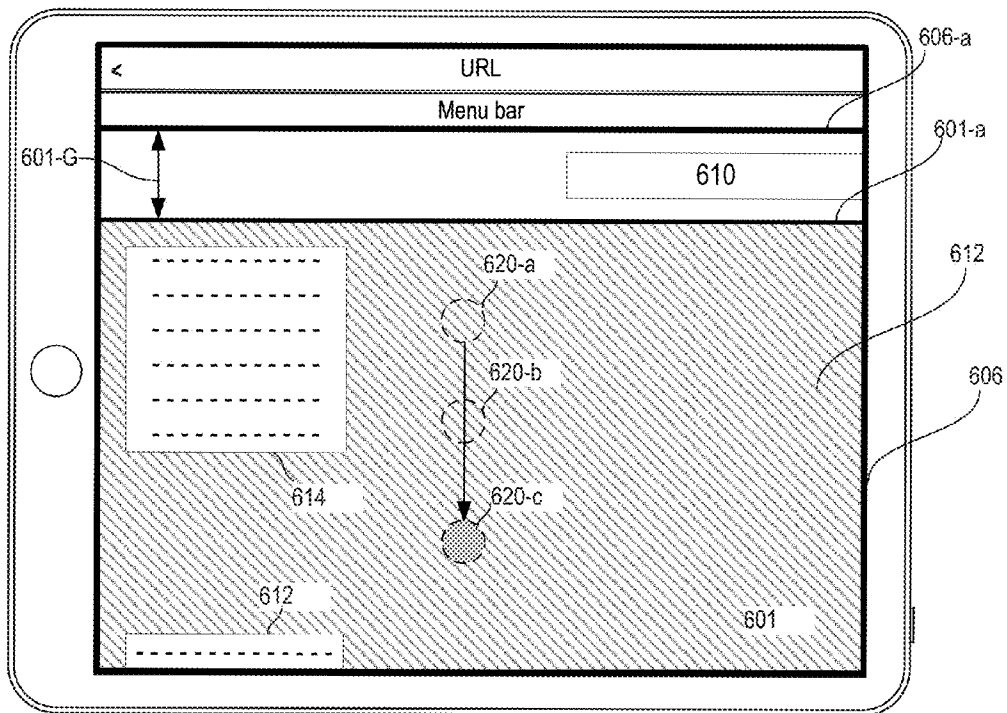


FIG. 6C

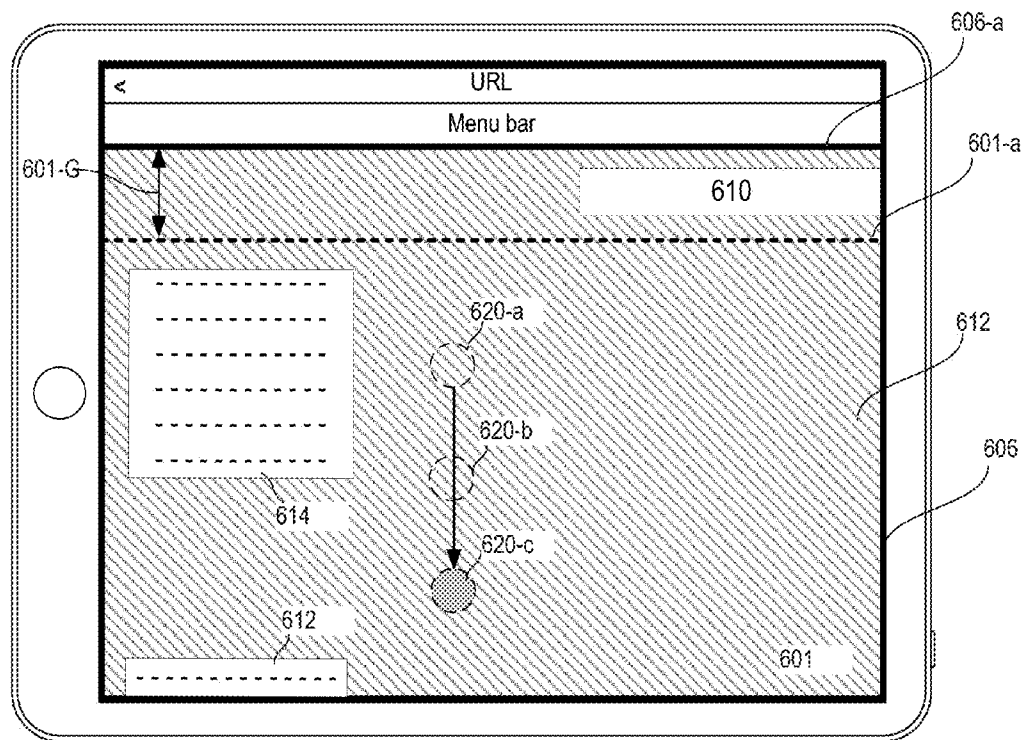


FIG. 6D



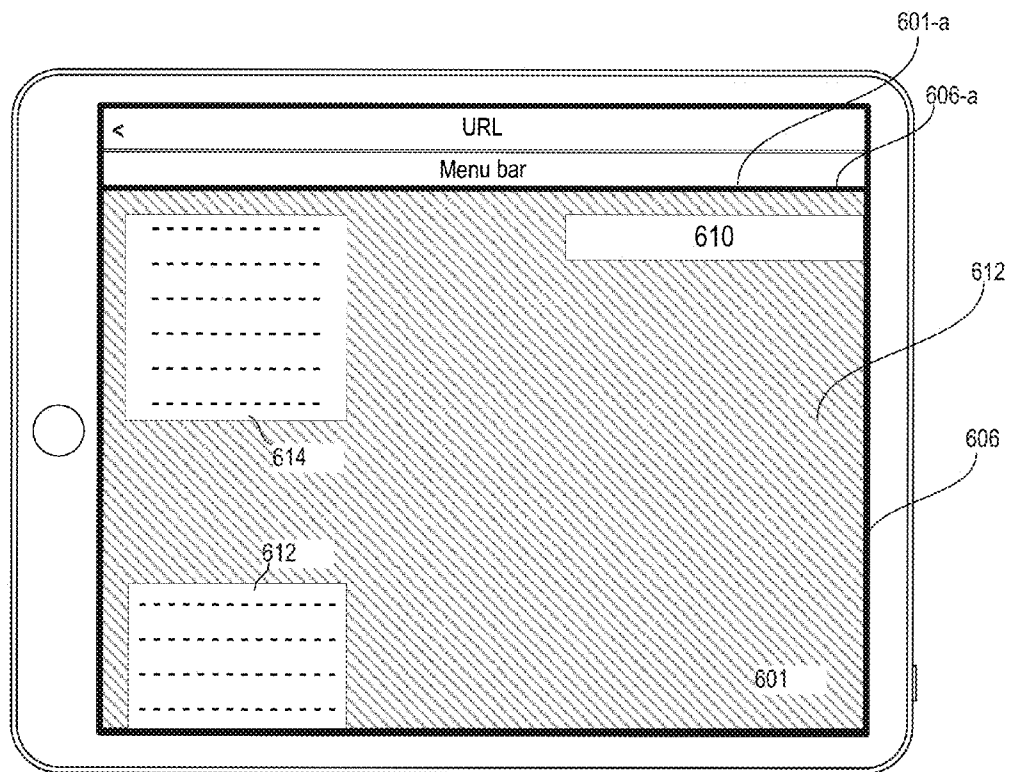


FIG. 6F

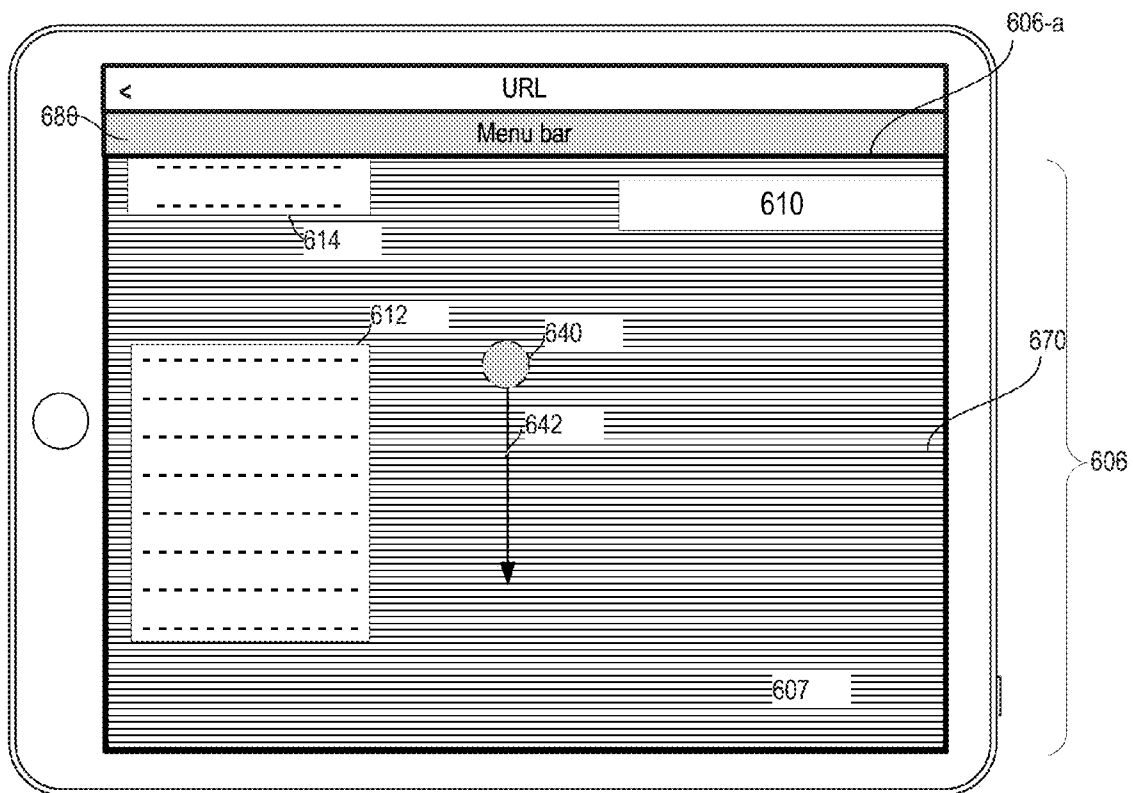


FIG. 6G



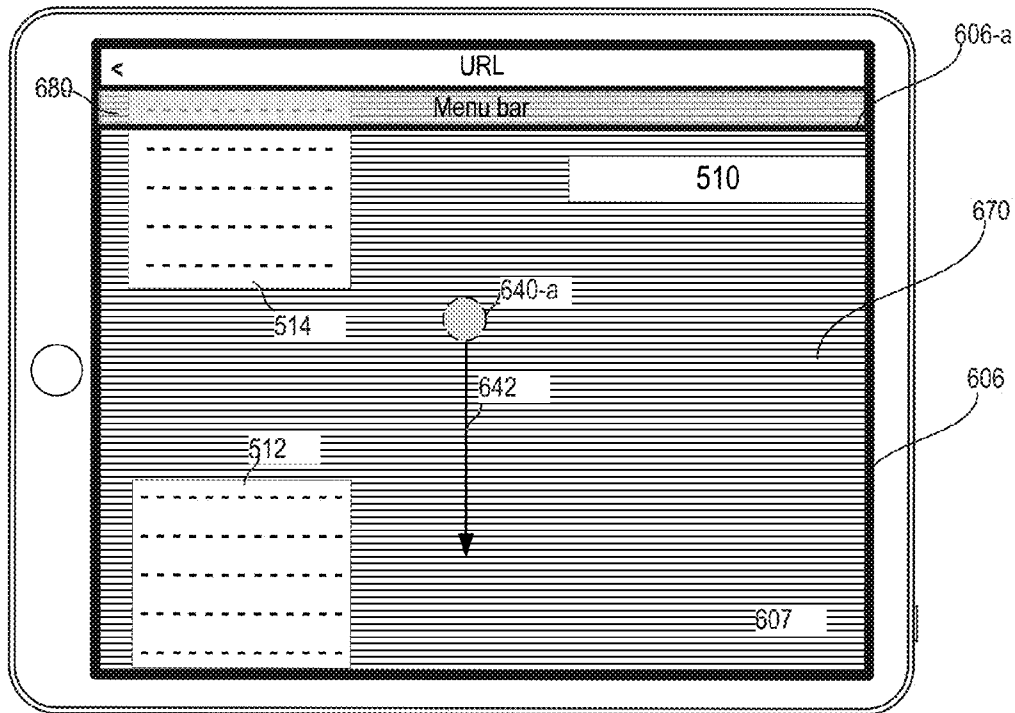


FIG. 6H

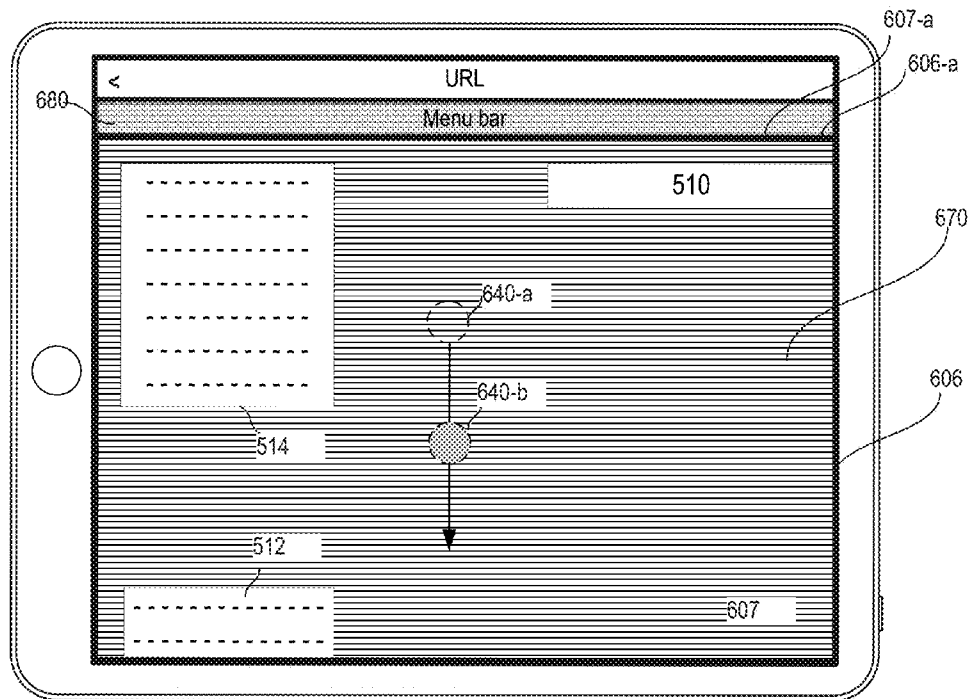


FIG. 6I

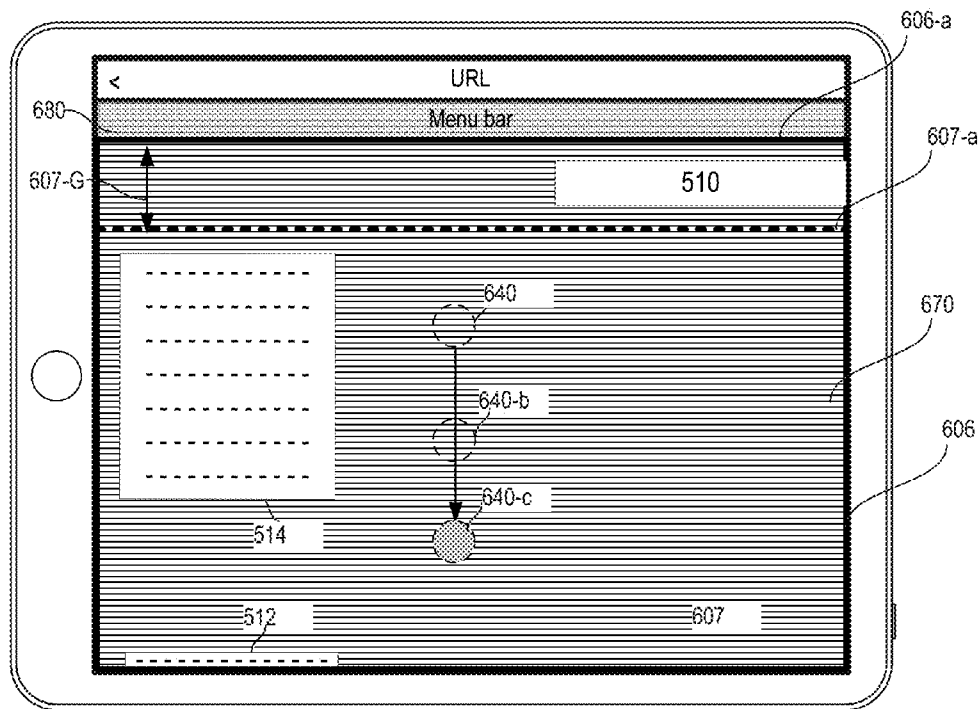


FIG. 6J

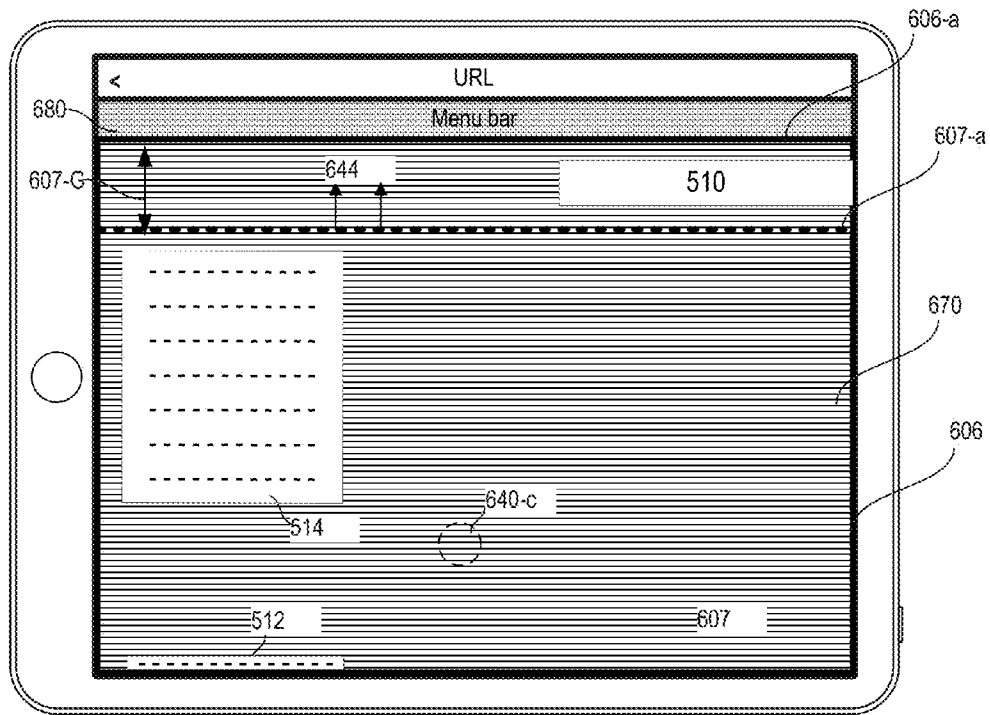


FIG. 6K

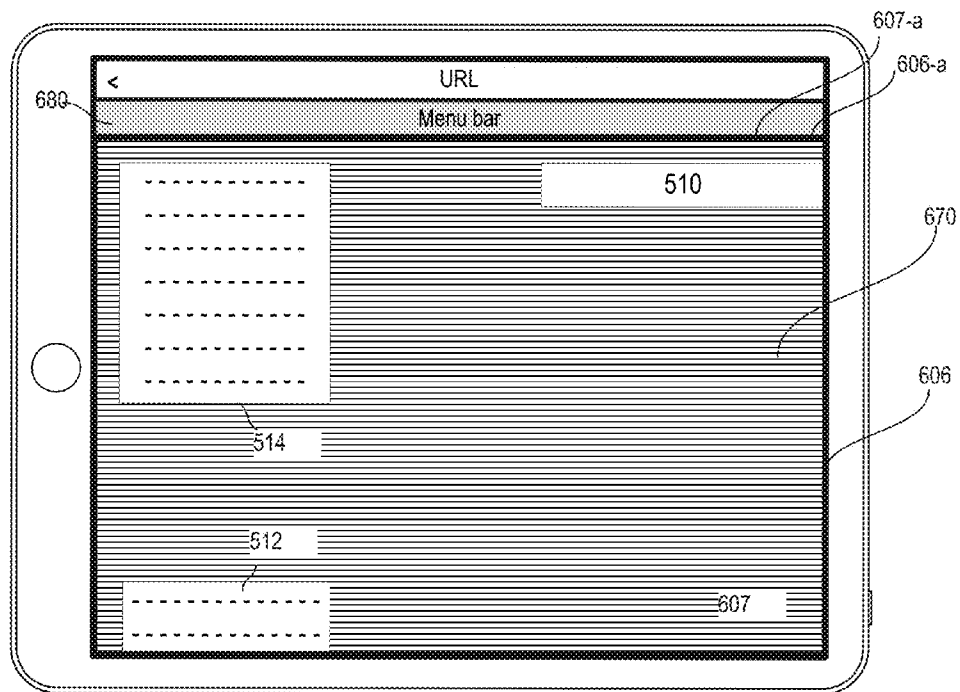


FIG. 6L



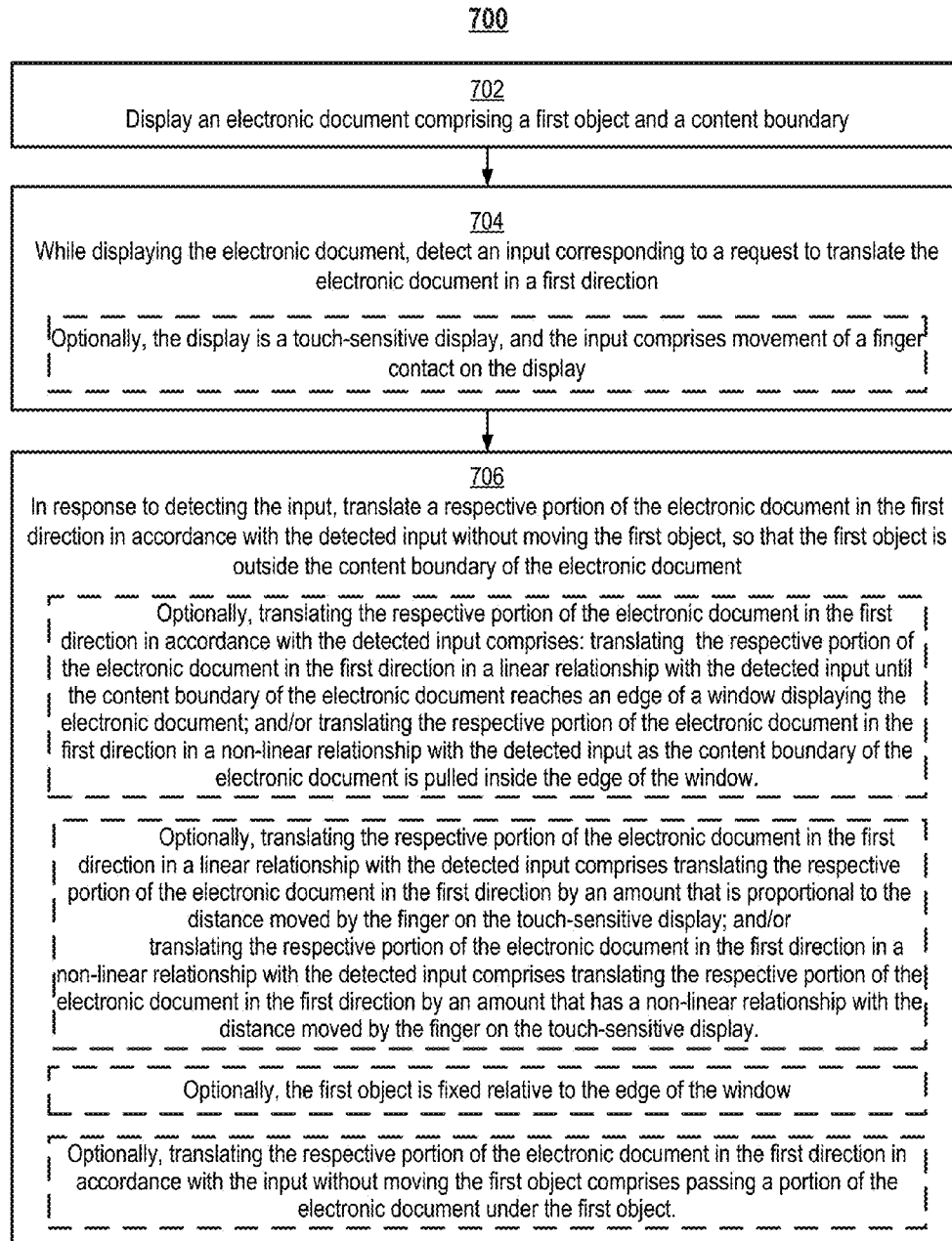


FIG. 7A

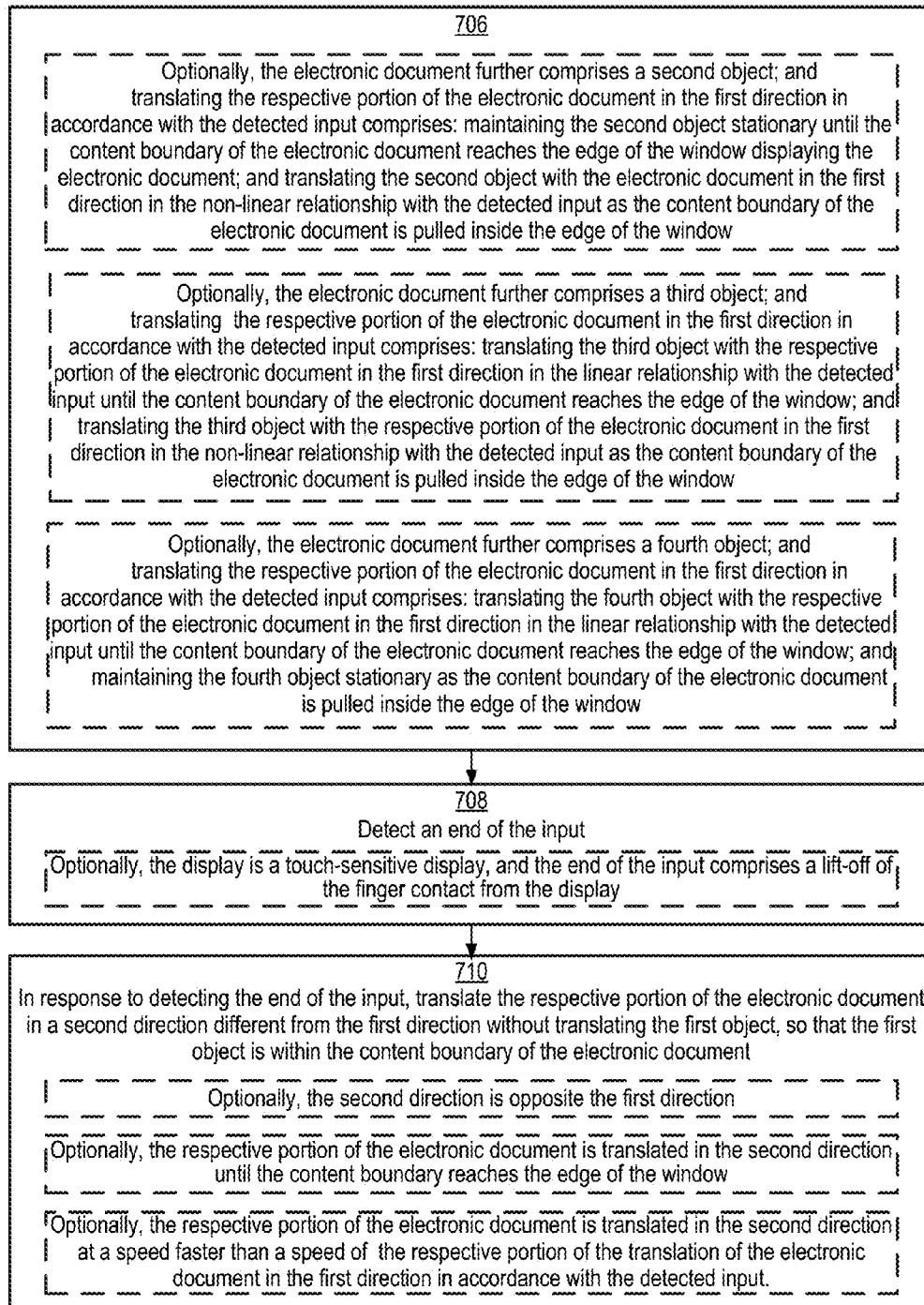


FIG. 7B

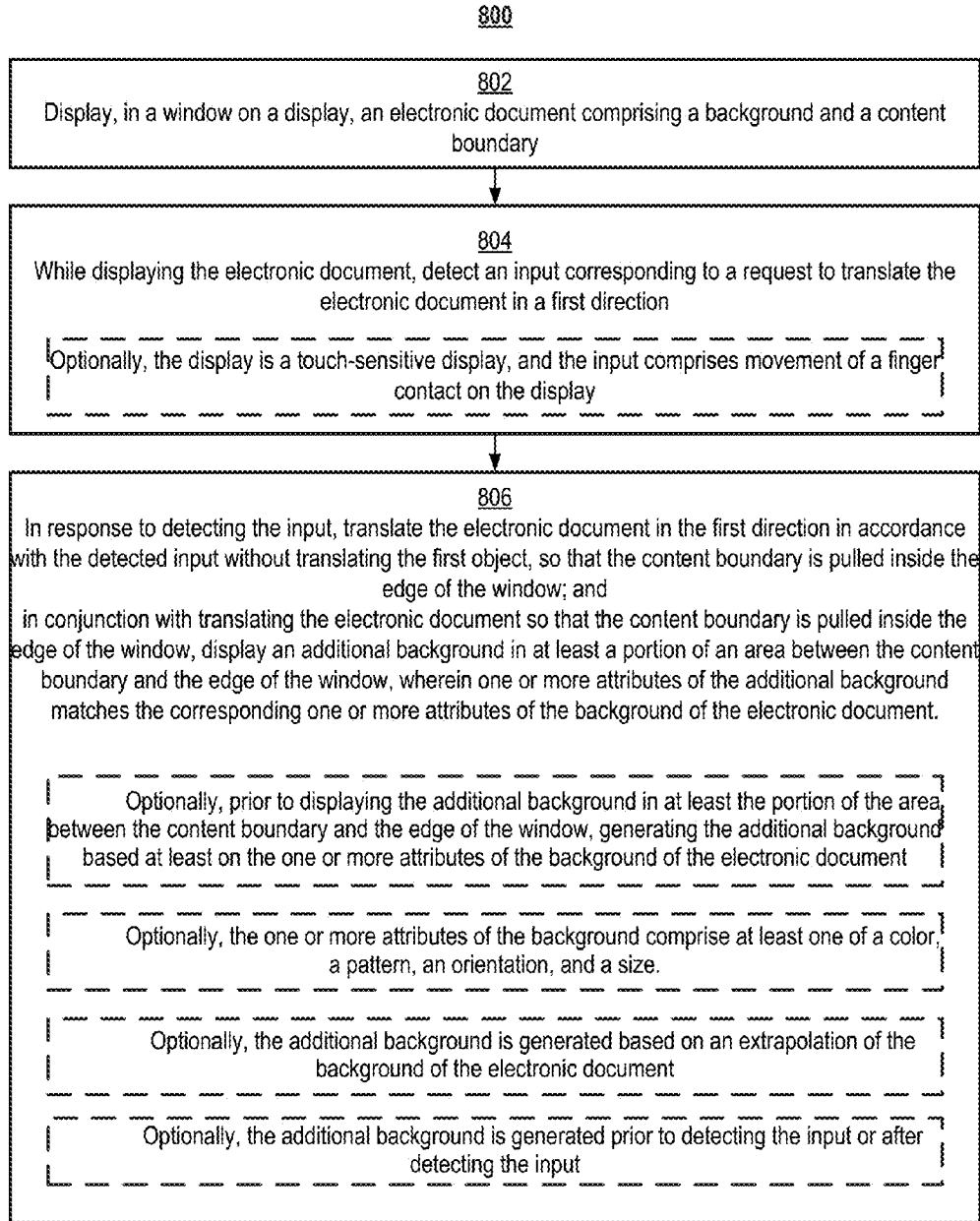


FIG. 8A

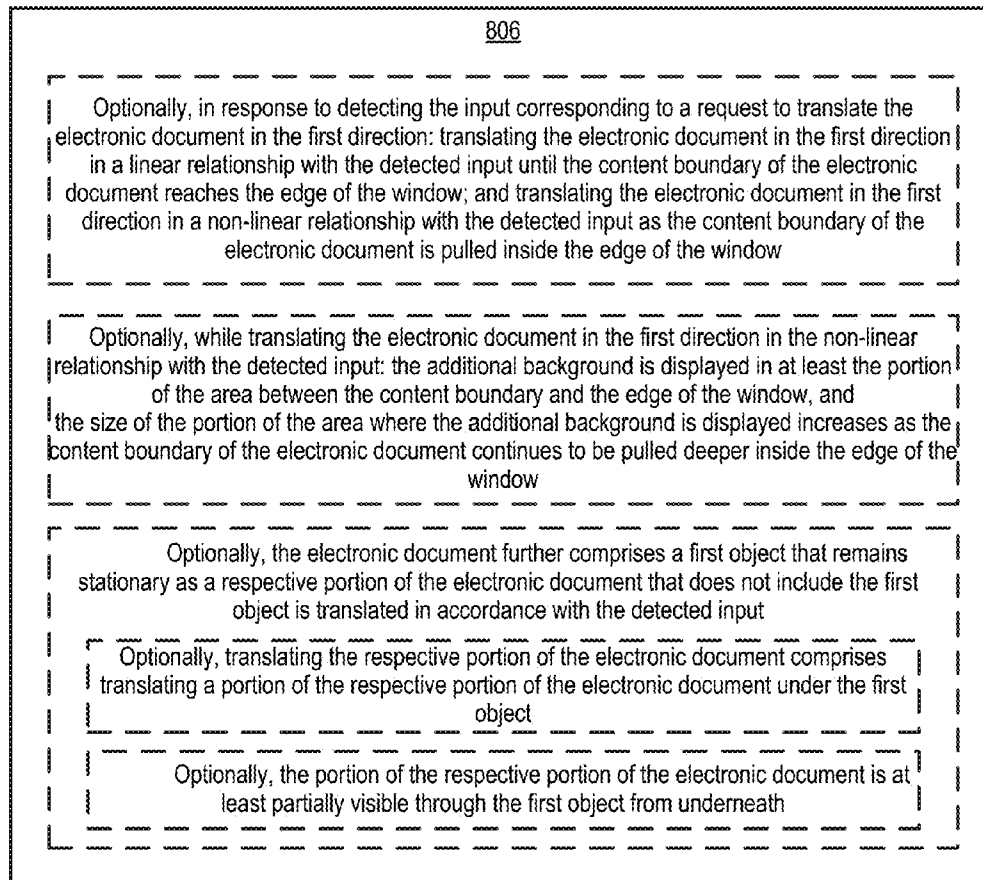


FIG. 8B

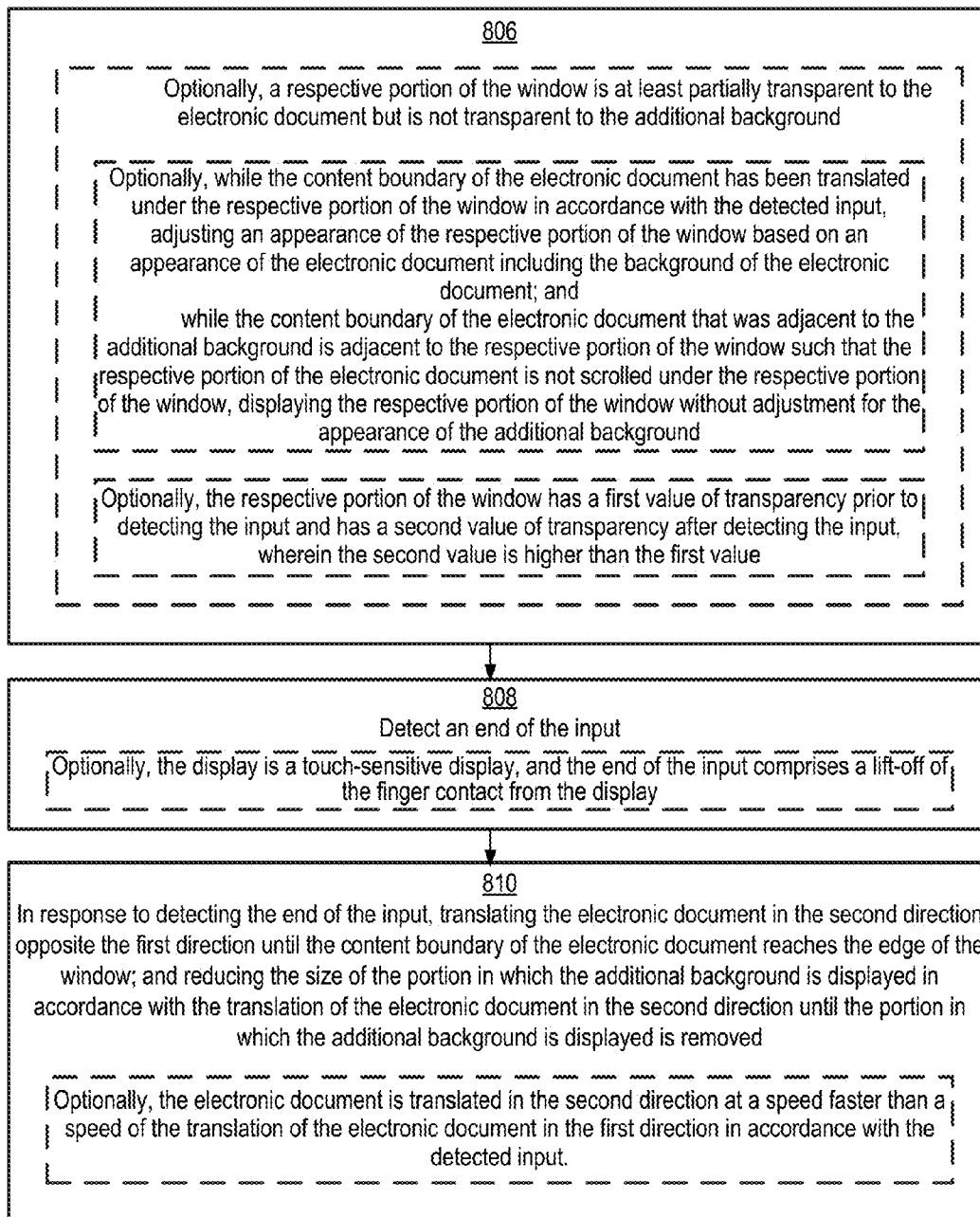


FIG. 8C

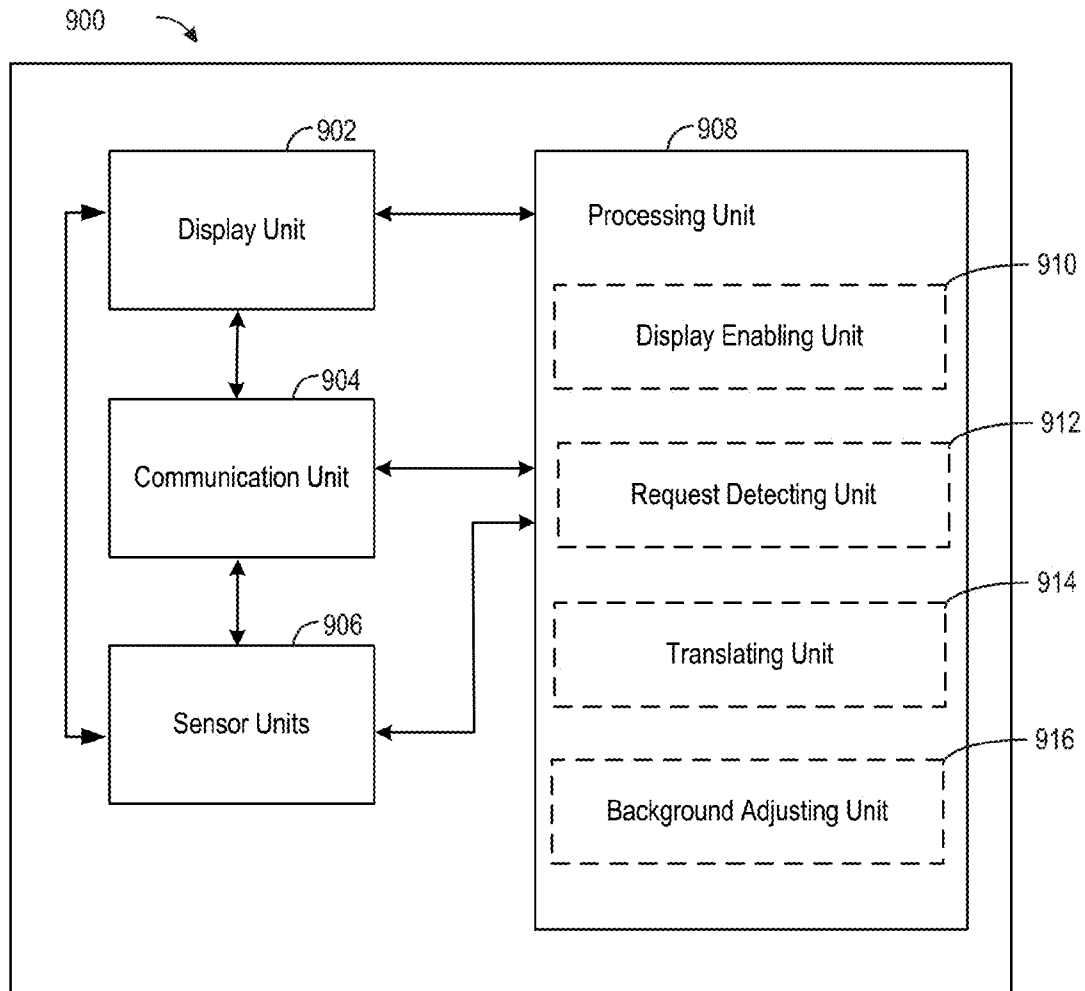


FIG. 9



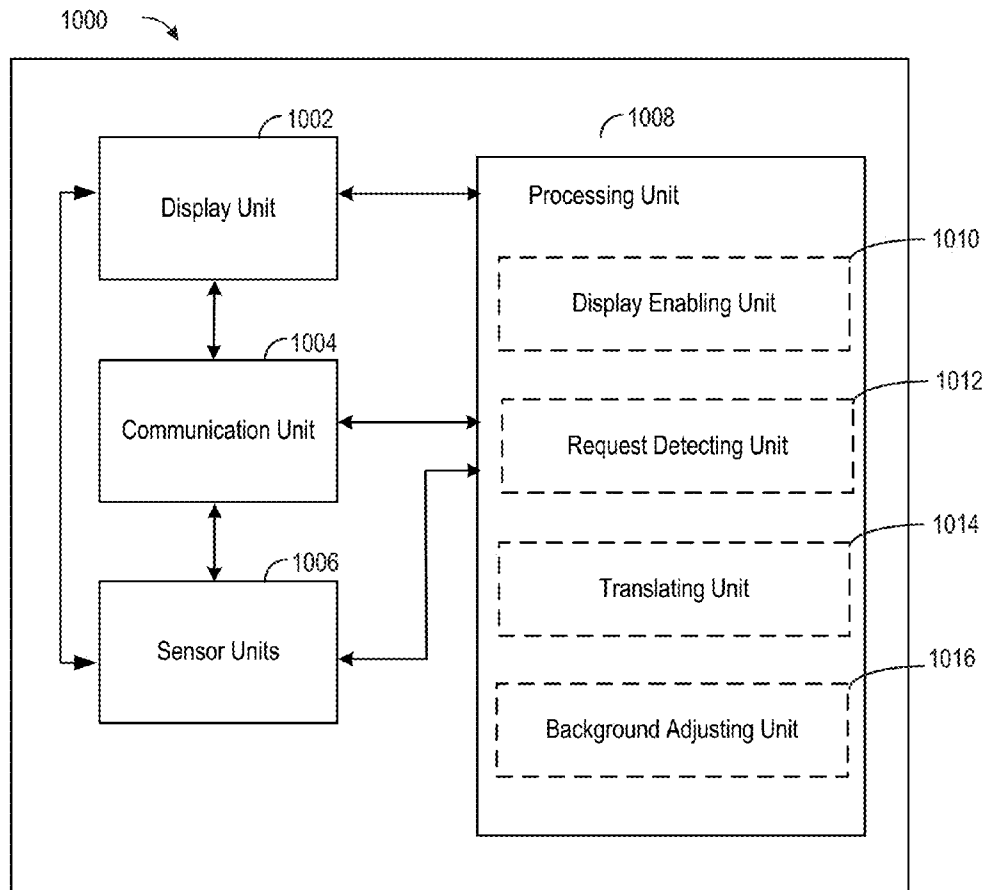


FIG. 10

US 2016/0202865 A1

Jul. 14, 2016

1

## **COORDINATION OF STATIC BACKGROUNDS AND RUBBERBANDING**

### **CROSS-REFERENCE TO RELATED APPLICATIONS**

[0001] This application claims benefit of U.S. Provisional Patent Application No. 62/101,346, entitled “COORDINATION OF STATIC BACKGROUND AND RUBBERBANDING,” filed Jan. 8, 2015, the entire contents of which are incorporated herein by reference.

### **FIELD OF THE DISCLOSURE**

[0002] This disclosure relates generally to a coordination of movements on a display of an electronic document and one or more objects contained in the electronic document.

### **BACKGROUND OF THE DISCLOSURE**

[0003] Modern display techniques often involve displaying moving contents on a display, for example, displaying a moving electronic document that includes other objects (e.g., text blocks, images, etc.). However, with an increasing complexity of movements required for electronic documents and individual components contained therein in modern display designs, a streamlined coordination of different movement behaviors of the electronic document and the contained objects is becoming more and more difficult. In view of these increasing difficulties, provided below are various techniques that can be used to easily and seamlessly coordinate the various different movement behaviors of an electronic document and a plurality of objects contained therewithin as they are subject to various different animation (e.g., movement) effects.

### **SUMMARY OF THE DISCLOSURE**

[0004] Described herein are various ways to coordinate different movement behaviors of an electronic document that includes one or more objects. Specifically, the description provided herein concerns moving an electronic document in the context of translation in response to a user input (e.g., scrolling)—for example, the electronic document is scrolled on a display as the user provides an associated scroll input, and, in some instances, the electronic document is subject to an animation effect known as “rubber-banding” at the end of document scrolling. In some embodiments, this behavior is also used as a “pull-to-refresh” function to cause the displayed electronic document to be refreshed.

[0005] There are various components of this rubber-banding behavior—the electronic document is scrolled in one way in accordance with the scroll input provided by the user, but starts scrolling in a different way once certain conditions arise (e.g., scrolling beyond an edge of the document). This behavior also includes movement of the electronic document even after the scroll input stops being provided by the user (e.g., restoration behavior), as will be explained in further detail below.

[0006] The descriptions below provide various techniques for coordinating movements of the electronic document and objects contained therein as the electronic document undergoes the rubber band effect, and the different objects contained in the electronic document optionally show different or similar movement behaviors as the electronic document.

[0007] While the descriptions provided herein primarily concern the coordinated movements of the electronic docu-

ment and objects in the context of the animation of scrolling and rubber banding, the concepts and teachings of the present disclosure are applied to many other types of animation effects (e.g., flashing effect, swirl effect) as will be apparent to those skilled in the art. Such applications and permutations are deemed within the scope of the present disclosure.

[0008] In some embodiments, an electronic device with a display is provided. The device displays, on the display, an electronic document that includes a first object and a content boundary. While displaying the electronic document, the device detects an input corresponding to a request to translate the electronic document in a first direction, and in response to detecting the input corresponding to a request to translate the electronic document, the device translates a respective portion of the electronic document (e.g., the content boundary) in the first direction in accordance with the detected input without translating the first object, so that the first object is outside of the content boundary of the electronic document. After translating the respective portion of the electronic document without translating the first object, the device detects an end of the input. In response to detecting the end of the input, the device translates the respective portion of the electronic document in a second direction different from the first direction without translating the first object, so that the first object is within the content boundary of the electronic document.

[0009] Optionally, the first object is fixed relative to the edge of the window displaying the electronic document. Optionally, translating the respective portion of the electronic document in the first direction in accordance with the detected input without translating the first object includes passing a portion of the electronic document under the first object. For example, the first object is maintained in a fixed position relative to the window when the rest of the electronic document is subject to a rubber-band effect, even if that means that the edge of the electronic document is pulled out from under the first object.

[0010] Optionally, in response to detecting the end of the input, the respective portion of the electronic document is translated in the second direction at a speed faster than a speed of the translation of the respective portion of the electronic document in the first direction in accordance with the detected input. Optionally, in response to detecting the end of the input, the respective portion of the electronic document is translated in the second direction until the content boundary of the electronic document reaches the edge of the window. Optionally, the second direction is opposite the first direction.

[0011] Optionally, translating the respective portion of the electronic document in the first direction in accordance with the detected input includes: translating the respective portion of the electronic document in the first direction in a linear relationship with the detected input until the content boundary of the electronic document reaches an edge of a window displaying the electronic document; and translating the respective portion of the electronic document in the first direction in a non-linear relationship with the detected input as the content boundary of the electronic document is pulled inside the edge of the window.

[0012] Optionally, the display is a touch-sensitive display, and the detected input includes movement of a finger on the touch-sensitive display. Translating the respective portion of the electronic document in the first direction in a linear relationship with the detected input includes translating the electronic document in the first direction by an amount that is proportional to the distance moved by the finger on the touch-

US 2016/0202865 A1

Jul. 14, 2016

2

sensitive display; and translating the respective portion of the electronic document in the first direction in a non-linear relationship with the detected input includes translating the electronic document in the first direction by an amount that has a non-linear relationship with the distance moved by the finger on the touch-sensitive display.

**[0013]** Optionally, the electronic document further includes a second object. Translating the respective portion of the electronic document in the first direction in accordance with the detected input includes maintaining the second object stationary until the content boundary of the electronic document reaches the edge of the window displaying the electronic document; and translating the second object with the respective portion of the electronic document in the first direction in the non-linear relationship with the detected input as the content boundary of the electronic document is pulled inside the edge of the window.

**[0014]** Optionally, the electronic document further includes a third object. Translating the respective portion of the electronic document in the first direction in accordance with the detected input includes: translating the third object with the respective portion of the electronic document in the first direction in the linear relationship with the detected input until the content boundary of the electronic document reaches the edge of the window; and translating the third object with the respective portion of the electronic document in the first direction in the non-linear relationship with the detected input as the content boundary of the electronic document is pulled inside the edge of the window.

**[0015]** Optionally, the electronic document further includes a fourth object. Translating the respective portion of the electronic document in the first direction in accordance with the detected input includes: translating the fourth object with the respective portion of the electronic document in the first direction in the linear relationship with the detected input until the content boundary of the electronic document reaches the edge of the window; and maintaining the fourth object stationary as the content boundary of the electronic document is pulled inside the edge of the window.

**[0016]** In some embodiments, an electronic device with a display is provided. The device displays, in a window on the display, an electronic document comprising a background and a content boundary, and while displaying the electronic document, detects an input corresponding to a request to translate the electronic document in a first direction. In response to detecting the input corresponding to a request to translate the electronic document in the first direction, the device translates the electronic document in the first direction in accordance with the detected input so that the content boundary is pulled inside the edge of the window; and in conjunction with translating the electronic document as the content boundary is pulled inside the edge of the window, the device displays an additional background in at least a portion of an area between the content boundary and the edge of the window, wherein one or more attributes of the additional background matches the corresponding one or more attributes of the background of the electronic document.

**[0017]** Optionally, prior to displaying the additional background in at least the portion of the area between the content boundary and the edge of the window, the device generates the additional background based at least on the one or more attributes of the original background of the electronic document. For example, the information about the original background is obtained from the electronic document itself or any

other related documents (e.g., CSS). The additional background is generated by the device on an as-needed basis (e.g., procedurally generated by the device as conditions arise in which the electronic device scrolls beyond an edge of the electronic document in the window). Optionally, the additional background is generated prior to detecting the input that corresponds to a request to translate the electronic document beyond an edge of the electronic document. Optionally, the additional background is generated after detecting the input that corresponds to a request to translate the electronic document beyond an edge of the electronic document. Optionally, the one or more attributes of the background comprise at least one of a color, a gradient, a pattern, an orientation, and a size. Optionally, the additional background is generated based on an extrapolation of the background of the electronic document.

**[0018]** Optionally, in response to detecting the input corresponding to a request to translate the electronic document in the first direction, the device translates the electronic document in the first direction in a linear relationship with the detected input until the content boundary of the electronic document reaches the edge of the window; and translates the electronic document in the first direction in a non-linear relationship with the detected input as the content boundary of the electronic document is pulled inside the edge of the window.

**[0019]** Optionally, the electronic document further includes a first object that remains stationary as a respective portion of the electronic document that does not include the first object is translated in accordance with the detected input. Optionally, translating the respective portion of the electronic document includes translating, under the first object, at least a portion of the respective portion of the electronic document. Optionally, the portion of the respective portion of the electronic document is at least partially visible through the first object from underneath.

**[0020]** Optionally, while the electronic document is translated in the first direction in the non-linear relationship with the detected input, the additional background is displayed in at least the portion of the area between the content boundary and the edge of the window, and the size of the portion of the area where the additional background is displayed increases as the content boundary of the electronic document continues to be pulled further inside the edge of the window.

**[0021]** Optionally, a respective portion of the window (e.g., a toolbar, a menu bar, etc.) is at least partially transparent to the electronic document but is not transparent to the additional background. Optionally, while a portion of the electronic document has been scrolled under the respective portion of the window, the device adjusts an appearance of the respective portion of the window based on an appearance of the electronic document including the background of the electronic document; and while an edge of the electronic document that was adjacent to the additional background is adjacent to the respective portion of the window such that the electronic document is not scrolled under the respective portion of the window, the device displays the respective portion of the window without adjustment for the appearance of the additional background. For example, the additional background is not displayed through the semi-transparent menu bar as it is not actually part of the document. This creates the appearance that the “extra background” being generated just in time to be displayed on display.

**[0022]** Optionally, the device detects an end of the input corresponding to a request to translate the electronic docu-

US 2016/0202865 A1

Jul. 14, 2016

3

ment in the first direction (e.g., a liftoff of the contact), and in response to detecting the end of the input corresponding to a request to translate the electronic document in the first direction, the device translates the electronic document in the second direction different from the first direction, so that the content boundary of the electronic document substantially coincides with the edge of the window; and removes the display of the additional background. Optionally, the second direction is opposite the first direction.

**[0023]** While the illustrated embodiments are described in the context of the electronic document translating in accordance with the scroll input, the concept of different object behavior coordination can be applied to various other types of the movement of the electronic document such as, non-exclusively, a translation based on an input other than a user input (e.g., a change in the orientation of the device) and automatic translation after an elapse of a predetermined time period.

#### BRIEF DESCRIPTION OF THE DRAWINGS

**[0024]** For a better understanding of the aforementioned embodiments of the invention as well as additional embodiments thereof, reference should be made to the Description of Embodiments below, in conjunction with the following drawings in which like reference numerals refer to corresponding parts throughout the figures.

**[0025]** FIG. 1A is a block diagram illustrating a portable multifunction device with a touch-sensitive display in accordance with some embodiments.

**[0026]** FIG. 1B is a block diagram illustrating exemplary components for event handling in accordance with some embodiments.

**[0027]** FIG. 2 illustrates a portable multifunction device having a touch-sensitive display in accordance with some embodiments.

**[0028]** FIG. 3 is a block diagram of an exemplary multifunction device with a display and a touch-sensitive surface in accordance with some embodiments.

**[0029]** FIGS. 4A and 4B illustrate an exemplary user interface for a menu of applications on a portable multifunction device in accordance with some embodiments.

**[0030]** FIGS. 5A-5F illustrate an exemplary implementation of coordinated movements of an electronic document and an object of a first type according to various embodiments of the disclosure.

**[0031]** FIGS. 5G-5K illustrate an exemplary implementation of coordinated movements of an electronic document and an object of a second type according to various embodiments of the disclosure.

**[0032]** FIGS. 5L-5P illustrate an exemplary implementation of coordinated movements of an electronic document and an object of a fourth type according to various embodiments of the disclosure. FIGS. 5A-5P also illustrate an exemplary implementation of coordinated movements of an electronic document and an object of a third type according to various embodiments of the disclosure.

**[0033]** FIGS. 5Q-5T illustrate a further exemplary implementation of coordinated movements of an electronic document and an object of a first type according to various embodiments of the disclosure.

**[0034]** FIGS. 6A-6F illustrate an exemplary implementation of coordinated movement of an electronic document with a background according to various embodiments of the disclosure.

**[0035]** FIGS. 6G-6L illustrate an exemplary implementation of coordinated movement of an electronic document with a background according to various embodiments of the disclosure.

**[0036]** FIGS. 7A-7B illustrate an exemplary flow diagram of coordinating movements of an electronic document and various objects contained therein according to various embodiments of the disclosure.

**[0037]** FIGS. 8A-8C illustrate an exemplary flow diagram of coordinating movements of an electronic document with a background and objects contained in the electronic document according to various embodiments of the disclosure.

**[0038]** FIG. 9 is a functional block diagram of an electronic device according to various embodiments of the disclosure.

**[0039]** FIG. 10 is a functional block diagram of an electronic device according to various embodiments of the disclosure.

#### DETAILED DESCRIPTION

**[0040]** Modern display techniques often involve displaying moving contents on a display, for example, displaying a moving electronic document that includes other objects (e.g., text blocks, images, etc.). However, with an ever-increasing complexity of movements required for electronic documents and individual components contained therein in modern display designs, a streamlined coordination of different movement behaviors of the electronic document and the contained objects is needed. Below described are various ways to coordinate different movement behaviors of an electronic document that includes one or more objects. Specifically, the description provided herein concern scrolling a document while maintaining display of relevant information (e.g., objects, toolbars, menus, other contents of the document). Also, appropriate feedback is provided when the user has reached an end of scrolling the document. For example, the electronic document is scrolled on a display as the user provides an associated scroll input (e.g., a touch and drag, a mouse drag) and, sometimes, the electronic document is subject to an animation effect known as “rubber-banding” when the user has reached an end of the document. Sometimes, this behavior is also used as a “pull-to-refresh” function to cause the displayed electronic document to be refreshed.

**[0041]** There are various components of the rubber-banding effect—for example, the electronic document is scrolled in one way in accordance with the scroll input provided by the user, but the electronic document starts scrolling in a different way once a certain condition is met. This behavior also includes a certain type of movement of the electronic document even after the scroll input stops (e.g., a restoration behavior), as will be explained in further detail below. To still add another layer of complexity, some individual objects contained in the electronic document show movement behaviors that are different from that of the electronic document as it is subject to the scrolling and rubber-banding. These movements of the objects and the electronic document are coordinated so as to not create a jarring effect on the display that would be distracting or confusing to the users and to prevent the users from experiencing any disruption in the animated movements of various objects displayed on the display.

**[0042]** For example, while the electronic document is scrolled, some objects are moved with the electronic document while other objects remain stationary. Optionally, the electronic document is subject to the rubber band effect as the user continues to scroll the electronic document after the user



US 2016/0202865 A1

Jul. 14, 2016

4

has reached the end of the document. While the electronic document is subject to the rubber band effect, some objects are subject to the rubber band effect along with the electronic document while other objects remain stationary and are not subject to the rubber band effect. Optionally, as the electronic document is subject to the rubber band effect (e.g., pulling an edge of the electronic document inside the edge of the display window), a gap is created between the pulled edge of the electronic document and the edge of the display window. Optionally, this gap is displayed with a background created based on the background of the electronic document so as to bring about the visual effect of this gap area being an extended background from the electronic document.

**[0043]** In the following description of the disclosure and embodiments, reference is made to the accompanying drawings in which it is shown by way of illustration specific embodiments that can be practiced. It is to be understood that other embodiments and examples can be practiced and changes can be made without departing from the scope of the disclosure.

**[0044]** Below, FIGS. 1A-1B, 2, 3 and 4A-4B provide a description of exemplary devices that display movement of an electronic document with one or more graphical objects of various types. FIGS. 5A-5R illustrate exemplary implementations of the rubber-band effect with the coordinated behavior of the moving electronic document with various types of objects that behave differently in response to the movement of the document. FIGS. 6A-6J illustrate exemplary implementations of the rubber-band effect with the extended background filling at least a portion of the gap that is created as the user pulls the document boundary inside the display window. The various coordination techniques illustrated in these figures are also used to illustrate the methods and processes described below, including the processes in FIGS. 7A-7B and 8A-8C.

**[0045]** Although the following description uses terms “first,” “second,” etc. to describe various elements, these elements should not be limited by the terms. These terms are only used to distinguish one element from another. For example, a first touch could be termed a second touch, and, similarly, a second touch could be termed a first touch, without departing from the scope of the various described embodiments. The first touch and the second touch are both touches, but they are not the same touch.

**[0046]** The terminology used in the description of the various described embodiments herein is for the purpose of describing particular embodiments only and is not intended to be limiting. As used in the description of the various described embodiments and the appended claims, the singular forms “a,” “an,” and “the” are intended to include the plural forms as well, unless the context clearly indicates otherwise. It will also be understood that the term “and/or” as used herein refers to and encompasses any and all possible combinations of one or more of the associated listed items. It will be further understood that the terms “includes,” “including,” “comprises,” and/or “comprising,” when used in this specification, specify the presence of stated features, integers, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, integers, steps, operations, elements, components, and/or groups thereof.

**[0047]** The terminology used in the description of the various described embodiments herein is for the purpose of describing particular embodiments only and is not intended to be limiting. As used in the description of the various described

embodiments and the appended claims, the singular forms “a,” “an,” and “the” are intended to include the plural forms as well, unless the context clearly indicates otherwise. It will also be understood that the term “and/or” as used herein refers to and encompasses any and all possible combinations of one or more of the associated listed items. It will be further understood that the terms “includes,” “including,” “comprises,” and/or “comprising,” when used in this specification, specify the presence of stated features, integers, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, integers, steps, operations, elements, components, and/or groups thereof.

**[0048]** The term “if” may be construed to mean “when” or “upon” or “in response to determining” or “in response to detecting,” depending on the context. Similarly, the phrase “if it is determined” or “if [a stated condition or event] is detected” may be construed to mean “upon determining” or “in response to determining” or “upon detecting [the stated condition or event]” or “in response to detecting [the stated condition or event],” depending on the context.

**[0049]** Embodiments of electronic devices, user interfaces for such devices, and associated processes for using such devices are described. In some embodiments, the device is a portable communications device, such as a mobile telephone, that also contains other functions, such as PDA and/or music player functions. Exemplary embodiments of portable multifunction devices include, without limitation, the iPhone®, iPod Touch®, and iPad® devices from Apple Inc. of Cupertino, Calif. Other portable electronic devices, such as laptops or tablet computers with touch-sensitive surfaces (e.g., touch screen displays and/or touchpads), are, optionally, used. It should also be understood that, in some embodiments, the device is not a portable communications device, but is a desktop computer with a touch-sensitive surface (e.g., a touch screen display and/or a touchpad).

**[0050]** In the discussion that follows, an electronic device that includes a display and a touch-sensitive surface is described. It should be understood, however, that the electronic device optionally includes one or more other physical user-interface devices, such as a physical keyboard, a mouse, and/or a joystick.

**[0051]** The device may support a variety of applications, such as one or more of the following: a drawing application, a presentation application, a word processing application, a website creation application, a disk authoring application, a spreadsheet application, a gaming application, a telephone application, a video conferencing application, an e-mail application, an instant messaging application, a workout support application, a photo management application, a digital camera application, a digital video camera application, a web browsing application, a digital music player application, and/or a digital video player application.

**[0052]** The various applications that are executed on the device optionally use at least one common physical user-interface device, such as the touch-sensitive surface. One or more functions of the touch-sensitive surface as well as corresponding information displayed on the device are, optionally, adjusted and/or varied from one application to the next and/or within a respective application. In this way, a common physical architecture (such as the touch-sensitive surface) of the device optionally supports the variety of applications with user interfaces that are intuitive and transparent to the user.

**[0053]** Attention is now directed toward embodiments of portable devices with touch-sensitive displays. FIG. 1A is a

US 2016/0202865 A1

Jul. 14, 2016

5

block diagram illustrating portable multifunction device **100** with touch-sensitive display system **112** in accordance with some embodiments. Touch-sensitive display **112** is sometimes called a “touch screen” for convenience and is sometimes known as or called a “touch-sensitive display system.” Device **100** includes memory **102** (which optionally includes one or more computer-readable storage mediums), memory controller **122**, one or more processing units (CPUs) **120**, peripherals interface **118**, RF circuitry **108**, audio circuitry **110**, speaker **111**, microphone **113**, input/output (I/O) subsystem **106**, other input control devices **116**, and external port **124**. Device **100** optionally includes one or more optical sensors **164**. Device **100** optionally includes one or more contact intensity sensors **165** for detecting intensity of contacts on device **100** (e.g., a touch-sensitive surface such as touch-sensitive display system **112** of device **100**). Device **100** optionally includes one or more tactile output generators **167** for generating tactile outputs on device **100** (e.g., generating tactile outputs on a touch-sensitive surface such as touch-sensitive display system **112** of device **100** or touchpad **355** of device **300**). These components optionally communicate over one or more communication buses or signal lines **103**.

**[0054]** As used in the specification and claims, the term “intensity” of a contact on a touch-sensitive surface refers to the force or pressure (force per unit area) of a contact (e.g., a finger contact) on the touch-sensitive surface, or to a substitute (proxy) for the force or pressure of a contact on the touch-sensitive surface. The intensity of a contact has a range of values that includes at least four distinct values and more typically includes hundreds of distinct values (e.g., at least 256). Intensity of a contact is, optionally, determined (or measured) using various approaches and various sensors or combinations of sensors. For example, one or more force sensors underneath or adjacent to the touch-sensitive surface are, optionally, used to measure force at various points on the touch-sensitive surface. In some implementations, force measurements from multiple force sensors are combined (e.g., a weighted average) to determine an estimated force of a contact. Similarly, a pressure-sensitive tip of a stylus is, optionally, used to determine a pressure of the stylus on the touch-sensitive surface. Alternatively, the size of the contact area detected on the touch-sensitive surface and/or changes thereto, the capacitance of the touch-sensitive surface proximate to the contact and/or changes thereto, and/or the resistance of the touch-sensitive surface proximate to the contact and/or changes thereto are, optionally, used as a substitute for the force or pressure of the contact on the touch-sensitive surface. In some implementations, the substitute measurements for contact force or pressure are used directly to determine whether an intensity threshold has been exceeded (e.g., the intensity threshold is described in units corresponding to the substitute measurements). In some implementations, the substitute measurements for contact force or pressure are converted to an estimated force or pressure, and the estimated force or pressure is used to determine whether an intensity threshold has been exceeded (e.g., the intensity threshold is a pressure threshold measured in units of pressure). Using the intensity of a contact as an attribute of a user input allows for user access to additional device functionality that may otherwise not be accessible by the user on a reduced-size device with limited real estate for displaying affordances (e.g., on a touch-sensitive display) and/or receiving user input (e.g., via

a touch-sensitive display, a touch-sensitive surface, or a physical/mechanical control such as a knob or a button).

**[0055]** As used in the specification and claims, the term “tactile output” refers to physical displacement of a device relative to a previous position of the device, physical displacement of a component (e.g., a touch-sensitive surface) of a device relative to another component (e.g., housing) of the device, or displacement of the component relative to a center of mass of the device that will be detected by a user with the user’s sense of touch. For example, in situations where the device or the component of the device is in contact with a surface of a user that is sensitive to touch (e.g., a finger, palm, or other part of a user’s hand), the tactile output generated by the physical displacement will be interpreted by the user as a tactile sensation corresponding to a perceived change in physical characteristics of the device or the component of the device. For example, movement of a touch-sensitive surface (e.g., a touch-sensitive display or trackpad) is, optionally, interpreted by the user as a “down click” or “up click” of a physical actuator button. In some cases, a user will feel a tactile sensation such as an “down click” or “up click” even when there is no movement of a physical actuator button associated with the touch-sensitive surface that is physically pressed (e.g., displaced) by the user’s movements. As another example, movement of the touch-sensitive surface is, optionally, interpreted or sensed by the user as “roughness” of the touch-sensitive surface, even when there is no change in smoothness of the touch-sensitive surface. While such interpretations of touch by a user will be subject to the individualized sensory perceptions of the user, there are many sensory perceptions of touch that are common to a large majority of users. Thus, when a tactile output is described as corresponding to a particular sensory perception of a user (e.g., an “up click,” a “down click,” “roughness”), unless otherwise stated, the generated tactile output corresponds to physical displacement of the device or a component thereof that will generate the described sensory perception for a typical (or average) user.

**[0056]** It should be appreciated that device **100** is only one example of a portable multifunction device, and that device **100** optionally has more or fewer components than shown, optionally combines two or more components, or optionally has a different configuration or arrangement of the components. The various components shown in FIG. 1A are implemented in hardware, software, or a combination of both hardware and software, including one or more signal processing and/or application-specific integrated circuits.

**[0057]** Memory **102** may include one or more computer-readable storage mediums. The computer-readable storage mediums may be tangible and non-transitory. Memory **102** may include high-speed random access memory and may also include non-volatile memory, such as one or more magnetic disk storage devices, flash memory devices, or other non-volatile solid-state memory devices. Memory controller **122** may control access to memory **102** by other components of device **100**.

**[0058]** Peripherals interface **118** can be used to couple input and output peripherals of the device to CPU **120** and memory **102**. The one or more processors **120** run or execute various software programs and/or sets of instructions stored in memory **102** to perform various functions for device **100** and to process data. In some embodiments, peripherals interface **118**, CPU **120**, and memory controller **122** may be



US 2016/0202865 A1

Jul. 14, 2016

6

implemented on a single chip, such as chip **104**. In some other embodiments, they may be implemented on separate chips.

**[0059]** RF (radio frequency) circuitry **108** receives and sends RF signals, also called electromagnetic signals. RF circuitry **108** converts electrical signals to/from electromagnetic signals and communicates with communications networks and other communications devices via the electromagnetic signals. RF circuitry **108** optionally includes well-known circuitry for performing these functions, including but not limited to an antenna system, an RF transceiver, one or more amplifiers, a tuner, one or more oscillators, a digital signal processor, a CODEC chipset, a subscriber identity module (SIM) card, memory, and so forth. RF circuitry **108** optionally communicates with networks, such as the Internet, also referred to as the World Wide Web (WWW), an intranet and/or a wireless network, such as a cellular telephone network, a wireless local area network (LAN) and/or a metropolitan area network (MAN), and other devices by wireless communication. The RF circuitry **108** optionally includes well-known circuitry for detecting near field communication (NFC) fields, such as by a short-range communication radio. The wireless communication optionally uses any of a plurality of communications standards, protocols, and technologies, including but not limited to Global System for Mobile Communications (GSM), Enhanced Data GSM Environment (EDGE), high-speed downlink packet access (HSDPA), high-speed uplink packet access (HSUPA), Evolution, Data-Only (EV-DO), HSPA, HSPA+, Dual-Cell HSPA (DC-HSPDA), long term evolution (LTE), near field communication (NFC), wideband code division multiple access (W-CDMA), code division multiple access (CDMA), time division multiple access (TDMA), Bluetooth, Bluetooth Low Energy (BTLE), Wireless Fidelity (Wi-Fi) (e.g., IEEE 802.11a, IEEE 802.11b, IEEE 802.11g, IEEE 802.11n, and/or IEEE 802.11ac), voice over Internet Protocol (VoIP), Wi-MAX, a protocol for e-mail (e.g., Internet message access protocol (IMAP) and/or post office protocol (POP)), instant messaging (e.g., extensible messaging and presence protocol (XMPP), Session Initiation Protocol for Instant Messaging and Presence Leveraging Extensions (SIMPLE), Instant Messaging and Presence Service (IMPS)), and/or Short Message Service (SMS), or any other suitable communication protocol, including communication protocols not yet developed as of the filing date of this document.

**[0060]** Audio circuitry **110**, speaker **111**, and microphone **113** provide an audio interface between a user and device **100**. Audio circuitry **110** receives audio data from peripherals interface **118**, converts the audio data to an electrical signal, and transmits the electrical signal to speaker **111**. Speaker **111** converts the electrical signal to human-audible sound waves. Audio circuitry **110** also receives electrical signals converted by microphone **113** from sound waves. Audio circuitry **110** converts the electrical signal to audio data and transmits the audio data to peripherals interface **118** for processing. Audio data may be retrieved from and/or transmitted to memory **102** and/or RF circuitry **108** by peripherals interface **118**. In some embodiments, audio circuitry **110** also includes a headset jack (e.g., **212**, FIG. 2). The headset jack provides an interface between audio circuitry **110** and removable audio input/output peripherals, such as output-only headphones or a headset with both output (e.g., a headphone for one or both ears) and input (e.g., a microphone).

**[0061]** I/O subsystem **106** couples input/output peripherals on device **100**, such as touch screen **112** and other input

control devices **116**, to peripherals interface **118**. I/O subsystem **106** optionally includes display controller **156**, optical sensor controller **158**, intensity sensor controller **159**, haptic feedback controller **161**, and one or more input controllers **160** for other input or control devices. The one or more input controllers **160** receive/send electrical signals from/to other input control devices **116**. The other input control devices **116** optionally include physical buttons (e.g., push buttons, rocker buttons, etc.), dials, slider switches, joysticks, click wheels, and so forth. In some alternate embodiments, input controller (s) **160** are, optionally, coupled to any (or none) of the following: a keyboard, an infrared port, a USB port, and a pointer device such as a mouse. The one or more buttons (e.g., **208**, FIG. 2) optionally include an up/down button for volume control of speaker **111** and/or microphone **113**. The one or more buttons optionally include a push button (e.g., **206**, FIG. 2).

**[0062]** A quick press of the push button may disengage a lock of touch screen **112** or begin a process that uses gestures on the touch screen to unlock the device, as described in U.S. patent application Ser. No. 11/322,549, "Unlocking a Device by Performing Gestures on an Unlock Image," filed Dec. 23, 2005, U.S. Pat. No. 7,657,849, which is hereby incorporated by reference in its entirety. A longer press of the push button (e.g., **206**) may turn power to device **100** on or off. The user may be able to customize a functionality of one or more of the buttons. Touch screen **112** is used to implement virtual or soft buttons and one or more soft keyboards.

**[0063]** Touch-sensitive display **112** provides an input interface and an output interface between the device and a user. Display controller **156** receives and/or sends electrical signals from/to touch screen **112**. Touch screen **112** displays visual output to the user. The visual output may include graphics, text, icons, video, and any combination thereof (collectively termed "graphics"). In some embodiments, some or all of the visual output may correspond to user-interface objects.

**[0064]** Touch screen **112** has a touch-sensitive surface, sensor, or set of sensors that accepts input from the user based on haptic and/or tactile contact. Touch screen **112** and display controller **156** (along with any associated modules and/or sets of instructions in memory **102**) detect contact (and any movement or breaking of the contact) on touch screen **112** and convert the detected contact into interaction with user-interface objects (e.g., one or more soft keys, icons, web pages, or images) that are displayed on touch screen **112**. In an exemplary embodiment, a point of contact between touch screen **112** and the user corresponds to a finger of the user.

**[0065]** Touch screen **112** may use LCD (liquid crystal display) technology, LPD (light emitting polymer display) technology, or LED (light emitting diode) technology, although other display technologies may be used in other embodiments. Touch screen **112** and display controller **156** may detect contact and any movement or breaking thereof using any of a plurality of touch sensing technologies now known or later developed, including but not limited to capacitive, resistive, infrared, and surface acoustic wave technologies, as well as other proximity sensor arrays or other elements for determining one or more points of contact with touch screen **112**. In an exemplary embodiment, projected mutual capacitance sensing technology is used, such as that found in the iPhone® and iPod Touch® from Apple Inc. of Cupertino, Calif.

**[0066]** A touch-sensitive display in some embodiments of touch screen **112** may be analogous to the multi-touch sensitive touchpads described in the following U.S. Pat. No. 6,323,

US 2016/0202865 A1

Jul. 14, 2016

7

846 (Westerman et al.), U.S. Pat. No. 6,570,557 (Westerman et al.), and/or U.S. Pat. No. 6,677,932 (Westerman), and/or U.S. Patent Publication 2002/0015024A1, each of which is hereby incorporated by reference in its entirety. However, touch screen **112** displays visual output from device **100**, whereas touch-sensitive touchpads do not provide visual output.

**[0067]** A touch-sensitive display in some embodiments of touch screen **112** may be as described in the following applications: (1) U.S. patent application Ser. No. 11/381,313, "Multipoint Touch Surface Controller," filed May 2, 2006; (2) U.S. patent application Ser. No. 10/840,862, "Multipoint Touchscreen," filed May 6, 2004; (3) U.S. patent application Ser. No. 10/903,964, "Gestures For Touch Sensitive Input Devices," filed Jul. 30, 2004; (4) U.S. patent application Ser. No. 11/048,264, "Gestures For Touch Sensitive Input Devices," filed Jan. 31, 2005; (5) U.S. patent application Ser. No. 11/038,590, "Mode-Based Graphical User Interfaces For Touch Sensitive Input Devices," filed Jan. 18, 2005; (6) U.S. patent application Ser. No. 11/228,758, "Virtual Input Device Placement On A Touch Screen User Interface," filed Sep. 16, 2005; (7) U.S. patent application Ser. No. 11/228,700, "Operation Of A Computer With A Touch Screen Interface," filed Sep. 16, 2005; (8) U.S. patent application Ser. No. 11/228,737, "Activating Virtual Keys Of A Touch-Screen Virtual Keyboard," filed Sep. 16, 2005; and (9) U.S. patent application Ser. No. 11/367,749, "Multi-Functional Hand-Held Device," filed Mar. 3, 2006. All of these applications are incorporated by reference herein in their entirety.

**[0068]** Touch screen **112** may have a video resolution in excess of 100 dpi. In some embodiments, the touch screen has a video resolution of approximately 160 dpi. The user may make contact with touch screen **112** using any suitable object or appendage, such as a stylus, a finger, and so forth. In some embodiments, the user interface is designed to work primarily with finger-based contacts and gestures, which can be less precise than stylus-based input due to the larger area of contact of a finger on the touch screen. In some embodiments, the device translates the rough finger-based input into a precise pointer/cursor position or command for performing the actions desired by the user.

**[0069]** In some embodiments, in addition to the touch screen, device **100** may include a touchpad (not shown) for activating or deactivating particular functions. In some embodiments, the touchpad is a touch-sensitive area of the device that, unlike the touch screen, does not display visual output. The touchpad may be a touch-sensitive surface that is separate from touch screen **112** or an extension of the touch-sensitive surface formed by the touch screen.

**[0070]** Device **100** also includes power system **162** for powering the various components. Power system **162** may include a power management system, one or more power sources (e.g., battery, alternating current (AC)), a recharging system, a power failure detection circuit, a power converter or inverter, a power status indicator (e.g., a light-emitting diode (LED)) and any other components associated with the generation, management and distribution of power in portable devices.

**[0071]** Device **100** may also include one or more optical sensors **164**. FIG. 1A shows an optical sensor coupled to optical sensor controller **158** in I/O subsystem **106**. Optical sensor **164** may include charge-coupled device (CCD) or complementary metal-oxide semiconductor (CMOS) phototransistors. Optical sensor **164** receives light from the envi-

ronment, projected through one or more lenses, and converts the light to data representing an image. In conjunction with imaging module **143** (also called a camera module), optical sensor **164** may capture still images or video. In some embodiments, an optical sensor is located on the back of device **100**, opposite touch screen display **112** on the front of the device so that the touch screen display may be used as a viewfinder for still and/or video image acquisition. In some embodiments, an optical sensor is located on the front of the device so that the user's image may be obtained for video conferencing while the user views the other video conference participants on the touch screen display. In some embodiments, the position of optical sensor **164** can be changed by the user (e.g., by rotating the lens and the sensor in the device housing) so that a single optical sensor **164** may be used along with the touch screen display for both video conferencing and still and/or video image acquisition.

**[0072]** Device **100** optionally also includes one or more contact intensity sensors **165**. FIG. 1A shows a contact intensity sensor coupled to intensity sensor controller **159** in I/O subsystem **106**. Contact intensity sensor **165** optionally includes one or more piezoresistive strain gauges, capacitive force sensors, electric force sensors, piezoelectric force sensors, optical force sensors, capacitive touch-sensitive surfaces, or other intensity sensors (e.g., sensors used to measure the force (or pressure) of a contact on a touch-sensitive surface). Contact intensity sensor **165** receives contact intensity information (e.g., pressure information or a proxy for pressure information) from the environment. In some embodiments, at least one contact intensity sensor is collocated with, or proximate to, a touch-sensitive surface (e.g., touch-sensitive display system **112**). In some embodiments, at least one contact intensity sensor is located on the back of device **100**, opposite touch screen display **112**, which is located on the front of device **100**.

**[0073]** Device **100** may also include one or more proximity sensors **166**. FIG. 1A shows proximity sensor **166** coupled to peripherals interface **118**. Alternately, proximity sensor **166** may be coupled to input controller **160** in I/O subsystem **106**. Proximity sensor **166** may perform as described in U.S. patent application Ser. No. 11/241,839, "Proximity Detector In Handheld Device"; Ser. No. 11/240,788, "Proximity Detector In Handheld Device"; Ser. No. 11/620,702, "Using Ambient Light Sensor To Augment Proximity Sensor Output"; Ser. No. 11/586,862, "Automated Response To And Sensing Of User Activity In Portable Devices"; and Ser. No. 11/638,251, "Methods And Systems For Automatic Configuration Of Peripherals," which are hereby incorporated by reference in their entirety. In some embodiments, the proximity sensor turns off and disables touch screen **112** when the multifunction device is placed near the user's ear (e.g., when the user is making a phone call).

**[0074]** Device **100** optionally also includes one or more tactile output generators **167**. FIG. 1A shows a tactile output generator coupled to haptic feedback controller **161** in I/O subsystem **106**. Tactile output generator **167** optionally includes one or more electroacoustic devices such as speakers or other audio components and/or electromechanical devices that convert energy into linear motion such as a motor, solenoid, electroactive polymer, piezoelectric actuator, electrostatic actuator, or other tactile output generating component (e.g., a component that converts electrical signals into tactile outputs on the device). Contact intensity sensor **165** receives tactile feedback generation instructions from haptic feedback

US 2016/0202865 A1

Jul. 14, 2016

8

module **133** and generates tactile outputs on device **100** that are capable of being sensed by a user of device **100**. In some embodiments, at least one tactile output generator is collocated with, or proximate to, a touch-sensitive surface (e.g., touch-sensitive display system **112**) and, optionally, generates a tactile output by moving the touch-sensitive surface vertically (e.g., in/out of a surface of device **100**) or laterally (e.g., back and forth in the same plane as a surface of device **100**). In some embodiments, at least one tactile output generator sensor is located on the back of device **100**, opposite touch screen display **112**, which is located on the front of device **100**.

[0075] Device **100** may also include one or more accelerometers **168**. FIG. 1A shows accelerometer **168** coupled to peripherals interface **118**. Alternately, accelerometer **168** may be coupled to an input controller **160** in I/O subsystem **106**. Accelerometer **168** may perform as described in U.S. Patent Publication No. 20050190059, "Acceleration-based Theft Detection System for Portable Electronic Devices," and U.S. Patent Publication No. 20060017692, "Methods And Apparatuses For Operating A Portable Device Based On An Accelerometer," both of which are incorporated by reference herein in their entirety. In some embodiments, information is displayed on the touch screen display in a portrait view or a landscape view based on an analysis of data received from the one or more accelerometers. Device **100** optionally includes, in addition to accelerometer(s) **168**, a magnetometer (not shown) and a GPS (or GLONASS or other global navigation system) receiver (not shown) for obtaining information concerning the location and orientation (e.g., portrait or landscape) of device **100**.

[0076] In some embodiments, the software components stored in memory **102** include operating system **126**, communication module (or set of instructions) **128**, contact/motion module (or set of instructions) **130**, graphics module (or set of instructions) **132**, text input module (or set of instructions) **134**, Global Positioning System (GPS) module (or set of instructions) **135**, and applications (or sets of instructions) **136**. Furthermore, in some embodiments, memory **102** (FIG. 1A) or **370** (FIG. 3) stores device/global internal state **157**, as shown in FIGS. 1A and 3. Device/global internal state **157** includes one or more of: active application state, indicating which applications, if any, are currently active; display state, indicating what applications, views or other information occupy various regions of touch screen display **112**; sensor state, including information obtained from the device's various sensors and input control devices **116**; and location information concerning the device's location and/or attitude.

[0077] Operating system **126** (e.g., Darwin, RTXC, LINUX, UNIX, OS X, iOS, WINDOWS, or an embedded operating system such as VxWorks) includes various software components and/or drivers for controlling and managing general system tasks (e.g., memory management, storage device control, power management, etc.) and facilitates communication between various hardware and software components.

[0078] Communication module **128** facilitates communication with other devices over one or more external ports **124** and also includes various software components for handling data received by RF circuitry **108** and/or external port **124**. External port **124** (e.g., Universal Serial Bus (USB), FIREWIRE, etc.) is adapted for coupling directly to other devices or indirectly over a network (e.g., the Internet, wireless LAN, etc.). In some embodiments, the external port is a

multi-pin (e.g., 30-pin) connector that is the same as, or similar to and/or compatible with, the 30-pin connector used on iPod® (trademark of Apple Inc.) devices.

[0079] Contact/motion module **130** optionally detects contact with touch screen **112** (in conjunction with display controller **156**) and other touch-sensitive devices (e.g., a touchpad or physical click wheel). Contact/motion module **130** includes various software components for performing various operations related to detection of contact, such as determining if contact has occurred (e.g., detecting a finger-down event), determining an intensity of the contact (e.g., the force or pressure of the contact or a substitute for the force or pressure of the contact), determining if there is movement of the contact and tracking the movement across the touch-sensitive surface (e.g., detecting one or more finger-dragging events), and determining if the contact has ceased (e.g., detecting a finger-up event or a break in contact). Contact/motion module **130** receives contact data from the touch-sensitive surface. Determining movement of the point of contact, which is represented by a series of contact data, optionally includes determining speed (magnitude), velocity (magnitude and direction), and/or an acceleration (a change in magnitude and/or direction) of the point of contact. These operations are, optionally, applied to single contacts (e.g., one finger contacts) or to multiple simultaneous contacts (e.g., "multi-touch"/multiple finger contacts). In some embodiments, contact/motion module **130** and display controller **156** detect contact on a touchpad.

[0080] In some embodiments, contact/motion module **130** uses a set of one or more intensity thresholds to determine whether an operation has been performed by a user (e.g., to determine whether a user has "clicked" on an icon). In some embodiments, at least a subset of the intensity thresholds are determined in accordance with software parameters (e.g., the intensity thresholds are not determined by the activation thresholds of particular physical actuators and can be adjusted without changing the physical hardware of device **100**). For example, a mouse "click" threshold of a trackpad or touch screen display can be set to any of a large range of predefined threshold values without changing the trackpad or touch screen display hardware. Additionally, in some implementations, a user of the device is provided with software settings for adjusting one or more of the set of intensity thresholds (e.g., by adjusting individual intensity thresholds and/or by adjusting a plurality of intensity thresholds at once with a system-level click "intensity" parameter).

[0081] Contact/motion module **130** optionally detects a gesture input by a user. Different gestures on the touch-sensitive surface have different contact patterns (e.g., different motions, timings, and/or intensities of detected contacts). Thus, a gesture is, optionally, detected by detecting a particular contact pattern. For example, detecting a finger tap gesture includes detecting a finger-down event followed by detecting a finger-up (liftoff) event at the same position (or substantially the same position) as the finger-down event (e.g., at the position of an icon). As another example, detecting a finger swipe gesture on the touch-sensitive surface includes detecting a finger-down event followed by detecting one or more finger-dragging events, and subsequently followed by detecting a finger-up (liftoff) event.

[0082] Graphics module **132** includes various known software components for rendering and displaying graphics on touch screen **112** or other display, including components for changing the visual impact (e.g., brightness, transparency,



US 2016/0202865 A1

Jul. 14, 2016

9

saturation, contrast, or other visual property) of graphics that are displayed. As used herein, the term “graphics” includes any object that can be displayed to a user, including, without limitation, text, web pages, icons (such as user-interface objects including soft keys), digital images, videos, animations, and the like.

[0083] In some embodiments, graphics module 132 stores data representing graphics to be used. Each graphic is, optionally, assigned a corresponding code. Graphics module 132 receives, from applications etc., one or more codes specifying graphics to be displayed along with, if necessary, coordinate data and other graphic property data, and then generates screen image data to output to display controller 156.

[0084] Haptic feedback module 133 includes various software components for generating instructions used by tactile output generator(s) 167 to produce tactile outputs at one or more locations on device 100 in response to user interactions with device 100.

[0085] Text input module 134, which may be a component of graphics module 132, provides soft keyboards for entering text in various applications (e.g., contacts 137, e-mail 140, IM 141, browser 147, and any other application that needs text input).

[0086] GPS module 135 determines the location of the device and provides this information for use in various applications (e.g., to telephone 138 for use in location-based dialing; to camera 143 as picture/video metadata; and to applications that provide location-based services such as weather widgets, local yellow page widgets, and map/navigation widgets).

[0087] Applications 136 may include the following modules (or sets of instructions), or a subset or superset thereof:

[0088] Contacts module 137 (sometimes called an address book or contact list);

[0089] Telephone module 138;

[0090] Video conferencing module 139;

[0091] E-mail client module 140;

[0092] Instant messaging (IM) module 141;

[0093] Workout support module 142;

[0094] Camera module 143 for still and/or video images;

[0095] Image management module 144;

[0096] Video player module;

[0097] Music player module;

[0098] Browser module 147;

[0099] Calendar module 148;

[0100] Widget modules 149, which may include one or more of: weather widget 149-1, stocks widget 149-2, calculator widget 149-3, alarm clock widget 149-4, dictionary widget 149-5, and other widgets obtained by the user, as well as user-created widgets 149-6;

[0101] Widget creator module 150 for making user-created widgets 149-6;

[0102] Search module 151;

[0103] Video and music player module 152, which merges video player module and music player module;

[0104] Notes module 153;

[0105] Map module 154; and/or

[0106] Online video module 155.

[0107] Examples of other applications 136 that may be stored in memory 102 include other word processing applications, other image editing applications, drawing applications, presentation applications, JAVA-enabled applications, encryption, digital rights management, voice recognition, and voice replication.

[0108] In conjunction with touch screen 112, display controller 156, contact/motion module 130, graphics module 132, and text input module 134, contacts module 137 may be used to manage an address book or contact list (e.g., stored in application internal state 192 of contacts module 137 in memory 102 or memory 370), including: adding name(s) to the address book; deleting name(s) from the address book; associating telephone number(s), e-mail address(es), physical address(es) or other information with a name; associating an image with a name; categorizing and sorting names; providing telephone numbers or e-mail addresses to initiate and/or facilitate communications by telephone 138, video conference 139, e-mail 140, or IM 141; and so forth.

[0109] In conjunction with RF circuitry 108, audio circuitry 110, speaker 111, microphone 113, touch screen 112, display controller 156, contact/motion module 130, graphics module 132, and text input module 134, telephone module 138 may be used to enter a sequence of characters corresponding to a telephone number, access one or more telephone numbers in contacts module 137, modify a telephone number that has been entered, dial a respective telephone number, conduct a conversation, and disconnect or hang up when the conversation is completed. As noted above, the wireless communication may use any of a plurality of communications standards, protocols, and technologies.

[0110] In conjunction with RF circuitry 108, audio circuitry 110, speaker 111, microphone 113, touch screen 112, display controller 156, optical sensor 164, optical sensor controller 158, contact/motion module 130, graphics module 132, text input module 134, contacts module 137, and telephone module 138, video conference module 139 includes executable instructions to initiate, conduct, and terminate a video conference between a user and one or more other participants in accordance with user instructions.

[0111] In conjunction with RF circuitry 108, touch screen 112, display controller 156, contact/motion module 130, graphics module 132, and text input module 134, e-mail client module 140 includes executable instructions to create, send, receive, and manage e-mail in response to user instructions. In conjunction with image management module 144, e-mail client module 140 makes it very easy to create and send e-mails with still or video images taken with camera module 143.

[0112] In conjunction with RF circuitry 108, touch screen 112, display controller 156, contact/motion module 130, graphics module 132, and text input module 134, the instant messaging module 141 includes executable instructions to enter a sequence of characters corresponding to an instant message, to modify previously entered characters, to transmit a respective instant message (for example, using a Short Message Service (SMS) or Multimedia Message Service (MMS) protocol for telephony-based instant messages or using XMPP, SIMPLE, or IMPS for Internet-based instant messages), to receive instant messages, and to view received instant messages. In some embodiments, transmitted and/or received instant messages may include graphics, photos, audio files, video files and/or other attachments as are supported in an MMS and/or an Enhanced Messaging Service (EMS). As used herein, “instant messaging” refers to both telephony-based messages (e.g., messages sent using SMS or MMS) and Internet-based messages (e.g., messages sent using XMPP, SIMPLE, or IMPS).

[0113] In conjunction with RF circuitry 108, touch screen 112, display controller 156, contact/motion module 130,

US 2016/0202865 A1

Jul. 14, 2016

10

graphics module 132, text input module 134, GPS module 135, map module 154, and music player module, workout support module 142 includes executable instructions to create workouts (e.g., with time, distance, and/or calorie burning goals); communicate with workout sensors (sports devices); receive workout sensor data; calibrate sensors used to monitor a workout; select and play music for a workout; and display, store, and transmit workout data.

[0114] In conjunction with touch screen 112, display controller 156, optical sensor(s) 164, optical sensor controller 158, contact/motion module 130, graphics module 132, and image management module 144, camera module 143 includes executable instructions to capture still images or video (including a video stream) and store them into memory 102, modify characteristics of a still image or video, or delete a still image or video from memory 102.

[0115] In conjunction with touch screen 112, display controller 156, contact/motion module 130, graphics module 132, text input module 134, and camera module 143, image management module 144 includes executable instructions to arrange, modify (e.g., edit), or otherwise manipulate, label, delete, present (e.g., in a digital slide show or album), and store still and/or video images.

[0116] In conjunction with RF circuitry 108, touch screen 112, display controller 156, contact/motion module 130, graphics module 132, and text input module 134, browser module 147 includes executable instructions to browse the Internet in accordance with user instructions, including searching, linking to, receiving, and displaying web pages or portions thereof, as well as attachments and other files linked to web pages.

[0117] In conjunction with RF circuitry 108, touch screen 112, display controller 156, contact/motion module 130, graphics module 132, text input module 134, e-mail client module 140, and browser module 147, calendar module 148 includes executable instructions to create, display, modify, and store calendars and data associated with calendars (e.g., calendar entries, to-do lists, etc.) in accordance with user instructions.

[0118] In conjunction with RF circuitry 108, touch screen 112, display controller 156, contact/motion module 130, graphics module 132, text input module 134, and browser module 147, widget modules 149 are mini-applications that may be downloaded and used by a user (e.g., weather widget 149-1, stocks widget 149-2, calculator widget 149-3, alarm clock widget 149-4, and dictionary widget 149-5) or created by the user (e.g., user-created widget 149-6). In some embodiments, a widget includes an HTML (Hypertext Markup Language) file, a CSS (Cascading Style Sheets) file, and a JavaScript file. In some embodiments, a widget includes an XML (Extensible Markup Language) file and a JavaScript file (e.g., Yahoo! Widgets).

[0119] In conjunction with RF circuitry 108, touch screen 112, display controller 156, contact/motion module 130, graphics module 132, text input module 134, and browser module 147, the widget creator module 150 may be used by a user to create widgets (e.g., turning a user-specified portion of a web page into a widget).

[0120] In conjunction with touch screen 112, display controller 156, contact/motion module 130, graphics module 132, and text input module 134, search module 151 includes executable instructions to search for text, music, sound, image, video, and/or other files in memory 102 that match one

or more search criteria (e.g., one or more user-specified search terms) in accordance with user instructions.

[0121] In conjunction with touch screen 112, display controller 156, contact/motion module 130, graphics module 132, audio circuitry 110, speaker 111, RF circuitry 108, and browser module 147, video and music player module 152 includes executable instructions that allow the user to download and play back recorded music and other sound files stored in one or more file formats, such as MP3 or AAC files, and executable instructions to display, present, or otherwise play back videos (e.g., on touch screen 112 or on an external, connected display via external port 124). In some embodiments, device 100 optionally includes the functionality of an MP3 player, such as an iPod (trademark of Apple Inc.).

[0122] In conjunction with touch screen 112, display controller 156, contact/motion module 130, graphics module 132, and text input module 134, notes module 153 includes executable instructions to create and manage notes, to-do lists, and the like in accordance with user instructions.

[0123] In conjunction with RF circuitry 108, touch screen 112, display controller 156, contact module 130, graphics module 132, text input module 134, GPS module 135, and browser module 147, map module 154 may be used to receive, display, modify, and store maps and data associated with maps (e.g., driving directions, data on stores and other points of interest at or near a particular location, and other location-based data) in accordance with user instructions.

[0124] In conjunction with touch screen 112, display controller 156, contact module 130, graphics module 132, audio circuitry 110, speaker 111, RF circuitry 108, text input module 134, e-mail client module 140, and browser module 147, online video module 155 includes instructions that allow the user to access, browse, receive (e.g., by streaming and/or download), play back (e.g., on the touch screen or on an external, connected display via external port 124), send an e-mail with a link to a particular online video, and otherwise manage online videos in one or more file formats, such as H.264. In some embodiments, instant messaging module 141, rather than e-mail client module 140, is used to send a link to a particular online video. Additional description of the online video application can be found in U.S. Provisional Patent Application No. 60/936,562, "Portable Multifunction Device, Method, and Graphical User Interface for Playing Online Videos," filed Jun. 20, 2007, and U.S. patent application Ser. No. 11/968,067, "Portable Multifunction Device, Method, and Graphical User Interface for Playing Online Videos," filed Dec. 31, 2007, the contents of which are hereby incorporated by reference in their entirety.

[0125] Each of the above-identified modules and applications corresponds to a set of executable instructions for performing one or more functions described above and the methods described in this application (e.g., the computer-implemented methods and other information processing methods described herein). These modules (e.g., sets of instructions) need not be implemented as separate software programs, procedures, or modules, and thus various subsets of these modules may be combined or otherwise rearranged in various embodiments. For example, video player module may be combined with music player module into a single module (e.g., video and music player module 152, FIG. 1A). In some embodiments, memory 102 may store a subset of the modules and data structures identified above. Furthermore, memory 102 may store additional modules and data structures not described above.

US 2016/0202865 A1

Jul. 14, 2016

11

[0126] In some embodiments, device 100 is a device where operation of a predefined set of functions on the device is performed exclusively through a touch screen and/or a touchpad. By using a touch screen and/or a touchpad as the primary input control device for operation of device 100, the number of physical input control devices (such as push buttons, dials, and the like) on device 100 may be reduced.

[0127] The predefined set of functions that are performed exclusively through a touch screen and/or a touchpad optionally include navigation between user interfaces. In some embodiments, the touchpad, when touched by the user, navigates device 100 to a main, home, or root menu from any user interface that is displayed on device 100. In such embodiments, a “menu button” is implemented using a touchpad. In some other embodiments, the menu button is a physical push button or other physical input control device instead of a touchpad.

[0128] FIG. 1B is a block diagram illustrating exemplary components for event handling in accordance with some embodiments. In some embodiments, memory 102 (FIG. 1A) or 370 (FIG. 3) includes event sorter 170 (e.g., in operating system 126) and a respective application 136-1 (e.g., any of the aforementioned applications 137-151, 155, 380-390).

[0129] Event sorter 170 receives event information and determines the application 136-1 and application view 191 of application 136-1 to which to deliver the event information. Event sorter 170 includes event monitor 171 and event dispatcher module 174. In some embodiments, application 136-1 includes application internal state 192, which indicates the current application view(s) displayed on touch-sensitive display 112 when the application is active or executing. In some embodiments, device/global internal state 157 is used by event sorter 170 to determine which application(s) is (are) currently active, and application internal state 192 is used by event sorter 170 to determine application views 191 to which to deliver event information.

[0130] In some embodiments, application internal state 192 includes additional information, such as one or more of: resume information to be used when application 136-1 resumes execution, user interface state information that indicates information being displayed or that is ready for display by application 136-1, a state queue for enabling the user to go back to a prior state or view of application 136-1, and a redo/undo queue of previous actions taken by the user.

[0131] Event monitor 171 receives event information from peripherals interface 118. Event information includes information about a sub-event (e.g., a user touch on touch-sensitive display 112, as part of a multi-touch gesture). Peripherals interface 118 transmits information it receives from I/O subsystem 106 or a sensor, such as proximity sensor 166, accelerometer(s) 168, and/or microphone 113 (through audio circuitry 110). Information that peripherals interface 118 receives from I/O subsystem 106 includes information from touch-sensitive display 112 or a touch-sensitive surface.

[0132] In some embodiments, event monitor 171 sends requests to the peripherals interface 118 at predetermined intervals. In response, peripherals interface 118 transmits event information. In other embodiments, peripherals interface 118 transmits event information only when there is a significant event (e.g., receiving an input above a predetermined noise threshold and/or for more than a predetermined duration).

[0133] In some embodiments, event sorter 170 also includes a hit view determination module 172 and/or an active event recognizer determination module 173.

[0134] Hit view determination module 172 provides software procedures for determining where a sub-event has taken place within one or more views when touch-sensitive display 112 displays more than one view. Views are made up of controls and other elements that a user can see on the display.

[0135] Another aspect of the user interface associated with an application is a set of views, sometimes herein called application views or user interface windows, in which information is displayed and touch-based gestures occur. The application views (of a respective application) in which a touch is detected may correspond to programmatic levels within a programmatic or view hierarchy of the application. For example, the lowest level view in which a touch is detected may be called the hit view, and the set of events that are recognized as proper inputs may be determined based, at least in part, on the hit view of the initial touch that begins a touch-based gesture.

[0136] Hit view determination module 172 receives information related to sub-events of a touch-based gesture. When an application has multiple views organized in a hierarchy, hit view determination module 172 identifies a hit view as the lowest view in the hierarchy which should handle the sub-event. In most circumstances, the hit view is the lowest level view in which an initiating sub-event occurs (e.g., the first sub-event in the sequence of sub-events that form an event or potential event). Once the hit view is identified by the hit view determination module 172, the hit view typically receives all sub-events related to the same touch or input source for which it was identified as the hit view.

[0137] Active event recognizer determination module 173 determines which view or views within a view hierarchy should receive a particular sequence of sub-events. In some embodiments, active event recognizer determination module 173 determines that only the hit view should receive a particular sequence of sub-events. In other embodiments, active event recognizer determination module 173 determines that all views that include the physical location of a sub-event are actively involved views, and therefore determines that all actively involved views should receive a particular sequence of sub-events. In other embodiments, even if touch sub-events were entirely confined to the area associated with one particular view, views higher in the hierarchy would still remain as actively involved views.

[0138] Event dispatcher module 174 dispatches the event information to an event recognizer (e.g., event recognizer 180). In embodiments including active event recognizer determination module 173, event dispatcher module 174 delivers the event information to an event recognizer determined by active event recognizer determination module 173. In some embodiments, event dispatcher module 174 stores in an event queue the event information, which is retrieved by a respective event receiver 182.

[0139] In some embodiments, operating system 126 includes event sorter 170. Alternatively, application 136-1 includes event sorter 170. In yet other embodiments, event sorter 170 is a stand-alone module, or a part of another module stored in memory 102, such as contact/motion module 130.

[0140] In some embodiments, application 136-1 includes a plurality of event handlers 190 and one or more application views 191, each of which includes instructions for handling



US 2016/0202865 A1

Jul. 14, 2016

12

touch events that occur within a respective view of the application's user interface. Each application view **191** of the application **136-1** includes one or more event recognizers **180**. Typically, a respective application view **191** includes a plurality of event recognizers **180**. In other embodiments, one or more of event recognizers **180** are part of a separate module, such as a user interface kit (not shown) or a higher level object from which application **136-1** inherits methods and other properties. In some embodiments, a respective event handler **190** includes one or more of: data updater **176**, object updater **177**, GUI updater **178**, and/or event data **179** received from event sorter **170**. Event handler **190** may utilize or call data updater **176**, object updater **177**, or GUI updater **178** to update the application internal state **192**. Alternatively, one or more of the application views **191** include one or more respective event handlers **190**. Also, in some embodiments, one or more of data updater **176**, object updater **177**, and GUI updater **178** are included in a respective application view **191**.

[0141] A respective event recognizer **180** receives event information (e.g., event data **179**) from event sorter **170** and identifies an event from the event information. Event recognizer **180** includes event receiver **182** and event comparator **184**. In some embodiments, event recognizer **180** also includes at least a subset of: metadata **183**, and event delivery instructions **188** (which may include sub-event delivery instructions).

[0142] Event receiver **182** receives event information from event sorter **170**. The event information includes information about a sub-event, for example, a touch or a touch movement. Depending on the sub-event, the event information also includes additional information, such as location of the sub-event. When the sub-event concerns motion of a touch, the event information may also include speed and direction of the sub-event. In some embodiments, events include rotation of the device from one orientation to another (e.g., from a portrait orientation to a landscape orientation, or vice versa), and the event information includes corresponding information about the current orientation (also called device attitude) of the device.

[0143] Event comparator **184** compares the event information to predefined event or sub-event definitions and, based on the comparison, determines an event or sub-event, or determines or updates the state of an event or sub-event. In some embodiments, event comparator **184** includes event definitions **186**. Event definitions **186** contain definitions of events (e.g., predefined sequences of sub-events), for example, event **1** (**187-1**), event **2** (**187-2**), and others. In some embodiments, sub-events in an event (**187**) include, for example, touch begin, touch end, touch movement, touch cancellation, and multiple touching. In one example, the definition for event **1** (**187-1**) is a double tap on a displayed object. The double tap, for example, comprises a first touch (touch begin) on the displayed object for a predetermined phase, a first liftoff (touch end) for a predetermined phase, a second touch (touch begin) on the displayed object for a predetermined phase, and a second liftoff (touch end) for a predetermined phase. In another example, the definition for event **2** (**187-2**) is a dragging on a displayed object. The dragging, for example, comprises a touch (or contact) on the displayed object for a predetermined phase, a movement of the touch across touch-sensitive display **112**, and liftoff of the touch (touch end). In some embodiments, the event also includes information for one or more associated event handlers **190**.

[0144] In some embodiments, event definition **187** includes a definition of an event for a respective user-interface object. In some embodiments, event comparator **184** performs a hit test to determine which user-interface object is associated with a sub-event. For example, in an application view in which three user-interface objects are displayed on touch-sensitive display **112**, when a touch is detected on touch-sensitive display **112**, event comparator **184** performs a hit test to determine which of the three user-interface objects is associated with the touch (sub-event). If each displayed object is associated with a respective event handler **190**, the event comparator uses the result of the hit test to determine which event handler **190** should be activated. For example, event comparator **184** selects an event handler associated with the sub-event and the object triggering the hit test.

[0145] In some embodiments, the definition for a respective event (**187**) also includes delayed actions that delay delivery of the event information until after it has been determined whether the sequence of sub-events does or does not correspond to the event recognizer's event type.

[0146] When a respective event recognizer **180** determines that the series of sub-events do not match any of the events in event definitions **186**, the respective event recognizer **180** enters an event impossible, event failed, or event ended state, after which it disregards subsequent sub-events of the touch-based gesture. In this situation, other event recognizers, if any, that remain active for the hit view continue to track and process sub-events of an ongoing touch-based gesture.

[0147] In some embodiments, a respective event recognizer **180** includes metadata **183** with configurable properties, flags, and/or lists that indicate how the event delivery system should perform sub-event delivery to actively involved event recognizers. In some embodiments, metadata **183** includes configurable properties, flags, and/or lists that indicate how event recognizers may interact, or are enabled to interact, with one another. In some embodiments, metadata **183** includes configurable properties, flags, and/or lists that indicate whether sub-events are delivered to varying levels in the view or programmatic hierarchy.

[0148] In some embodiments, a respective event recognizer **180** activates event handler **190** associated with an event when one or more particular sub-events of an event are recognized. In some embodiments, a respective event recognizer **180** delivers event information associated with the event to event handler **190**. Activating an event handler **190** is distinct from sending (and deferred sending) sub-events to a respective hit view. In some embodiments, event recognizer **180** throws a flag associated with the recognized event, and event handler **190** associated with the flag catches the flag and performs a predefined process.

[0149] In some embodiments, event delivery instructions **188** include sub-event delivery instructions that deliver event information about a sub-event without activating an event handler. Instead, the sub-event delivery instructions deliver event information to event handlers associated with the series of sub-events or to actively involved views. Event handlers associated with the series of sub-events or with actively involved views receive the event information and perform a predetermined process.

[0150] In some embodiments, data updater **176** creates and updates data used in application **136-1**. For example, data updater **176** updates the telephone number used in contacts module **137**, or stores a video file used in video player module. In some embodiments, object updater **177** creates and

US 2016/0202865 A1

Jul. 14, 2016

13

updates objects used in application 136-1. For example, object updater 177 creates a new user-interface object or updates the position of a user-interface object. GUI updater 178 updates the GUI. For example, GUI updater 178 prepares display information and sends it to graphics module 132 for display on a touch-sensitive display.

[0151] In some embodiments, event handler(s) 190 includes or has access to data updater 176, object updater 177, and GUI updater 178. In some embodiments, data updater 176, object updater 177, and GUI updater 178 are included in a single module of a respective application 136-1 or application view 191. In other embodiments, they are included in two or more software modules.

[0152] It shall be understood that the foregoing discussion regarding event handling of user touches on touch-sensitive displays also applies to other forms of user inputs to operate multifunction devices 100 with input devices, not all of which are initiated on touch screens. For example, mouse movement and mouse button presses, optionally coordinated with single or multiple keyboard presses or holds; contact movements such as taps, drags, scrolls, etc. on touchpads; pen stylus inputs; movement of the device; oral instructions; detected eye movements; biometric inputs; and/or any combination thereof are optionally utilized as inputs corresponding to sub-events which define an event to be recognized.

[0153] FIG. 2 illustrates a portable multifunction device 100 having a touch screen 112 in accordance with some embodiments. The touch screen optionally displays one or more graphics within user interface (UI) 200. In this embodiment, as well as others described below, a user is enabled to select one or more of the graphics by making a gesture on the graphics, for example, with one or more fingers 202 (not drawn to scale in the figure) or one or more styluses 203 (not drawn to scale in the figure). In some embodiments, selection of one or more graphics occurs when the user breaks contact with the one or more graphics. In some embodiments, the gesture optionally includes one or more taps, one or more swipes (from left to right, right to left, upward and/or downward), and/or a rolling of a finger (from right to left, left to right, upward and/or downward) that has made contact with device 100. In some implementations or circumstances, inadvertent contact with a graphic does not select the graphic. For example, a swipe gesture that sweeps over an application icon optionally does not select the corresponding application when the gesture corresponding to selection is a tap.

[0154] Device 100 may also include one or more physical buttons, such as “home” or menu button 204. As described previously, menu button 204 may be used to navigate to any application 136 in a set of applications that may be executed on device 100. Alternatively, in some embodiments, the menu button is implemented as a soft key in a GUI displayed on touch screen 112.

[0155] In one embodiment, device 100 includes touch screen 112, menu button 204, push button 206 for powering the device on/off and locking the device, volume adjustment button(s) 208, subscriber identity module (SIM) card slot 210, headset jack 212, and docking/charging external port 124. Push button 206 is, optionally, used to turn the power on/off on the device by depressing the button and holding the button in the depressed state for a predefined time interval; to lock the device by depressing the button and releasing the button before the predefined time interval has elapsed; and/or to unlock the device or initiate an unlock process. In an alternative embodiment, device 100 also accepts verbal input

for activation or deactivation of some functions through microphone 113. Device 100 also, optionally, includes one or more contact intensity sensors 165 for detecting intensity of contacts on touch screen 112 and/or one or more tactile output generators 167 for generating tactile outputs for a user of device 100.

[0156] FIG. 3 is a block diagram of an exemplary multifunction device with a display and a touch-sensitive surface in accordance with some embodiments. Device 300 need not be portable. In some embodiments, device 300 is a laptop computer, a desktop computer, a tablet computer, a multimedia player device, a navigation device, an educational device (such as a child’s learning toy), a gaming system, or a control device (e.g., a home or industrial controller). Device 300 typically includes one or more processing units (CPUs) 310, one or more network or other communications interfaces 360, memory 370, and one or more communication buses 320 for interconnecting these components. Communication buses 320 optionally include circuitry (sometimes called a chipset) that interconnects and controls communications between system components. Device 300 includes input/output (I/O) interface 330 comprising display 340, which is typically a touch screen display. I/O interface 330 also optionally includes a keyboard and/or mouse (or other pointing device) 350 and touchpad 355, tactile output generator 357 for generating tactile outputs on device 300 (e.g., similar to tactile output generator(s) 167 described above with reference to FIG. 1A), sensors 359 (e.g., optical, acceleration, proximity, touch-sensitive, and/or contact intensity sensors similar to contact intensity sensor(s) 165 described above with reference to FIG. 1A). Memory 370 includes high-speed random access memory, such as DRAM, SRAM, DDR RAM, or other random access solid state memory devices; and optionally includes non-volatile memory, such as one or more magnetic disk storage devices, optical disk storage devices, flash memory devices, or other non-volatile solid state storage devices. Memory 370 optionally includes one or more storage devices remotely located from CPU(s) 310. In some embodiments, memory 370 stores programs, modules, and data structures analogous to the programs, modules, and data structures stored in memory 102 of portable multifunction device 100 (FIG. 1A), or a subset thereof. Furthermore, memory 370 optionally stores additional programs, modules, and data structures not present in memory 102 of portable multifunction device 100. For example, memory 370 of device 300 optionally stores drawing module 380, presentation module 382, word processing module 384, website creation module 386, disk authoring module 388, and/or spreadsheet module 390, while memory 102 of portable multifunction device 100 (FIG. 1A) optionally does not store these modules.

[0157] Each of the above-identified elements in FIG. 3 may be stored in one or more of the previously mentioned memory devices. Each of the above-identified modules corresponds to a set of instructions for performing a function described above. The above-identified modules or programs (e.g., sets of instructions) need not be implemented as separate software programs, procedures, or modules, and thus various subsets of these modules may be combined or otherwise rearranged in various embodiments. In some embodiments, memory 370 may store a subset of the modules and data structures identified above. Furthermore, memory 370 may store additional modules and data structures not described above.

US 2016/0202865 A1

Jul. 14, 2016

14

[0158] Attention is now directed towards embodiments of user interfaces that may be implemented on, for example, portable multifunction device 100.

[0159] FIG. 4A illustrates an exemplary user interface for a menu of applications on portable multifunction device 100 in accordance with some embodiments. Similar user interfaces may be implemented on device 300. In some embodiments, user interface 400 includes the following elements, or a subset or superset thereof:

[0160] Signal strength indicator(s) 402 for wireless communication(s), such as cellular and Wi-Fi signals;

[0161] Time 404;

[0162] Bluetooth indicator 405;

[0163] Battery status indicator 406;

[0164] Tray 408 with icons for frequently used applications, such as:

[0165] Icon 416 for telephone module 138, labeled "Phone," which optionally includes an indicator 414 of the number of missed calls or voicemail messages;

[0166] Icon 418 for e-mail client module 140, labeled "Mail," which optionally includes an indicator 410 of the number of unread e-mails;

[0167] Icon 420 for browser module 147, labeled "Browser;" and

[0168] Icon 422 for video and music player module 152, also referred to as iPod (trademark of Apple Inc.) module 152, labeled "iPod;" and

[0169] Icons for other applications, such as:

[0170] Icon 424 for IM module 141, labeled "Messages;"

[0171] Icon 426 for calendar module 148, labeled "Calendar;"

[0172] Icon 428 for image management module 144, labeled "Photos;"

[0173] Icon 430 for camera module 143, labeled "Camera;"

[0174] Icon 432 for online video module 155, labeled "Online Video;"

[0175] Icon 434 for stocks widget 149-2, labeled "Stocks;"

[0176] Icon 436 for map module 154, labeled "Maps;"

[0177] Icon 438 for weather widget 149-1, labeled "Weather;"

[0178] Icon 440 for alarm clock widget 149-4, labeled "Clock;"

[0179] Icon 442 for workout support module 142, labeled "Workout Support;"

[0180] Icon 444 for notes module 153, labeled "Notes;" and

[0181] Icon 446 for a settings application or module, labeled "Settings," which provides access to settings for device 100 and its various applications 136.

[0182] It should be noted that the icon labels illustrated in FIG. 4A are merely exemplary. For example, icon 422 for video and music player module 152 may optionally be labeled "Music" or "Music Player." Other labels are, optionally, used for various application icons. In some embodiments, a label for a respective application icon includes a name of an application corresponding to the respective application icon. In some embodiments, a label for a particular application icon is distinct from a name of an application corresponding to the particular application icon.

[0183] FIG. 4B illustrates an exemplary user interface on a device (e.g., device 300, FIG. 3) with a touch-sensitive sur-

face 451 (e.g., a tablet or touchpad 355, FIG. 3) that is separate from the display 450 (e.g., touch screen display 112). Device 300 also, optionally, includes one or more contact intensity sensors (e.g., one or more of sensors 357) for detecting intensity of contacts on touch-sensitive surface 451 and/or one or more tactile output generators 359 for generating tactile outputs for a user of device 300.

[0184] Although some of the examples which follow will be given with reference to inputs on touch screen display 112 (where the touch-sensitive surface and the display are combined), in some embodiments, the device detects inputs on a touch-sensitive surface that is separate from the display, as shown in FIG. 4B. In some embodiments, the touch-sensitive surface (e.g., 451 in FIG. 4B) has a primary axis (e.g., 452 in FIG. 4B) that corresponds to a primary axis (e.g., 453 in FIG. 4B) on the display (e.g., 450). In accordance with these embodiments, the device detects contacts (e.g., 460 and 462 in FIG. 4B) with the touch-sensitive surface 451 at locations that correspond to respective locations on the display (e.g., in FIG. 4B, 460 corresponds to 468 and 462 corresponds to 470). In this way, user inputs (e.g., contacts 460 and 462, and movements thereof) detected by the device on the touch-sensitive surface (e.g., 451 in FIG. 4B) are used by the device to manipulate the user interface on the display (e.g., 450 in FIG. 4B) of the multifunction device when the touch-sensitive surface is separate from the display. It should be understood that similar methods are, optionally, used for other user interfaces described herein.

[0185] Additionally, while the following examples are given primarily with reference to finger inputs (e.g., finger contacts, finger tap gestures, finger swipe gestures), it should be understood that, in some embodiments, one or more of the finger inputs are replaced with input from another input device (e.g., a mouse-based input or stylus input). For example, a swipe gesture is, optionally, replaced with a mouse click (e.g., instead of a contact) followed by movement of the cursor along the path of the swipe (e.g., instead of movement of the contact). As another example, a tap gesture is, optionally, replaced with a mouse click while the cursor is located over the location of the tap gesture (e.g., instead of detection of the contact followed by ceasing to detect the contact). Similarly, when multiple user inputs are simultaneously detected, it should be understood that multiple computer mice are, optionally, used simultaneously, or a mouse and finger contacts are, optionally, used simultaneously.

[0186] As used here, the term "affordance" refers to a user-interactive graphical user interface object that may be displayed on the display screen of devices 100 and/or 300 (FIGS. 1 and 3). For example, an image (e.g., icon), a button, and text (e.g., hyperlink) may each constitute an affordance.

[0187] As used herein, the term "focus selector" refers to an input element that indicates a current part of a user interface with which a user is interacting. In some implementations that include a cursor or other location marker, the cursor acts as a "focus selector" so that when an input (e.g., a press input) is detected on a touch-sensitive surface (e.g., touchpad 355 in FIG. 3 or touch-sensitive surface 451 in FIG. 4B) while the cursor is over a particular user interface element (e.g., a button, window, slider or other user interface element), the particular user interface element is adjusted in accordance with the detected input. In some implementations that include a touch screen display (e.g., touch-sensitive display system 112 in FIG. 1A or touch screen 112 in FIG. 4A) that enables direct interaction with user interface elements on the touch



US 2016/0202865 A1

Jul. 14, 2016

15

screen display, a detected contact on the touch screen acts as a “focus selector” so that when an input (e.g., a press input by the contact) is detected on the touch screen display at a location of a particular user interface element (e.g., a button, window, slider, or other user interface element), the particular user interface element is adjusted in accordance with the detected input. In some implementations, focus is moved from one region of a user interface to another region of the user interface without corresponding movement of a cursor or movement of a contact on a touch screen display (e.g., by using a tab key or arrow keys to move focus from one button to another button); in these implementations, the focus selector moves in accordance with movement of focus between different regions of the user interface. Without regard to the specific form taken by the focus selector, the focus selector is generally the user interface element (or contact on a touch screen display) that is controlled by the user so as to communicate the user’s intended interaction with the user interface (e.g., by indicating, to the device, the element of the user interface with which the user is intending to interact). For example, the location of a focus selector (e.g., a cursor, a contact, or a selection box) over a respective button while a press input is detected on the touch-sensitive surface (e.g., a touchpad or touch screen) will indicate that the user is intending to activate the respective button (as opposed to other user interface elements shown on a display of the device).

**[0188]** As used in the specification and claims, the term “characteristic intensity” of a contact refers to a characteristic of the contact based on one or more intensities of the contact. In some embodiments, the characteristic intensity is based on multiple intensity samples. The characteristic intensity is, optionally, based on a predefined number of intensity samples, or a set of intensity samples collected during a predetermined time period (e.g., 0.05, 0.1, 0.2, 0.5, 1, 2, 5, 10 seconds) relative to a predefined event (e.g., after detecting the contact, prior to detecting liftoff of the contact, before or after detecting a start of movement of the contact, prior to detecting an end of the contact, before or after detecting an increase in intensity of the contact, and/or before or after detecting a decrease in intensity of the contact). A characteristic intensity of a contact is, optionally based on one or more of: a maximum value of the intensities of the contact, a mean value of the intensities of the contact, an average value of the intensities of the contact, a top 10 percentile value of the intensities of the contact, a value at the half maximum of the intensities of the contact, a value at the 90 percent maximum of the intensities of the contact, or the like. In some embodiments, the duration of the contact is used in determining the characteristic intensity (e.g., when the characteristic intensity is an average of the intensity of the contact over time). In some embodiments, the characteristic intensity is compared to a set of one or more intensity thresholds to determine whether an operation has been performed by a user. For example, the set of one or more intensity thresholds may include a first intensity threshold and a second intensity threshold. In this example, a contact with a characteristic intensity that does not exceed the first threshold results in a first operation, a contact with a characteristic intensity that exceeds the first intensity threshold and does not exceed the second intensity threshold results in a second operation, and a contact with a characteristic intensity that exceeds the second threshold results in a third operation. In some embodiments, a comparison between the characteristic intensity and one or more thresholds is used to determine whether or not to perform one or more opera-

tions (e.g., whether to perform a respective operation or forgo performing the respective operation) rather than being used to determine whether to perform a first operation or a second operation.

**[0189]** In some embodiments, a portion of a gesture is identified for purposes of determining a characteristic intensity. For example, a touch-sensitive surface may receive a continuous swipe contact transitioning from a start location and reaching an end location, at which point the intensity of the contact increases. In this example, the characteristic intensity of the contact at the end location may be based on only a portion of the continuous swipe contact, and not the entire swipe contact (e.g., only the portion of the swipe contact at the end location). In some embodiments, a smoothing algorithm may be applied to the intensities of the swipe contact prior to determining the characteristic intensity of the contact. For example, the smoothing algorithm optionally includes one or more of: an unweighted sliding-average smoothing algorithm, a triangular smoothing algorithm, a median filter smoothing algorithm, and/or an exponential smoothing algorithm. In some circumstances, these smoothing algorithms eliminate narrow spikes or dips in the intensities of the swipe contact for purposes of determining a characteristic intensity.

**[0190]** The intensity of a contact on the touch-sensitive surface may be characterized relative to one or more intensity thresholds, such as a contact-detection intensity threshold, a light press intensity threshold, a deep press intensity threshold, and/or one or more other intensity thresholds. In some embodiments, the light press intensity threshold corresponds to an intensity at which the device will perform operations typically associated with clicking a button of a physical mouse or a trackpad. In some embodiments, the deep press intensity threshold corresponds to an intensity at which the device will perform operations that are different from operations typically associated with clicking a button of a physical mouse or a trackpad. In some embodiments, when a contact is detected with a characteristic intensity below the light press intensity threshold (e.g., and above a nominal contact-detection intensity threshold below which the contact is no longer detected), the device will move a focus selector in accordance with movement of the contact on the touch-sensitive surface without performing an operation associated with the light press intensity threshold or the deep press intensity threshold. Generally, unless otherwise stated, these intensity thresholds are consistent between different sets of user interface figures.

**[0191]** An increase of characteristic intensity of the contact from an intensity below the light press intensity threshold to an intensity between the light press intensity threshold and the deep press intensity threshold is sometimes referred to as a “light press” input. An increase of characteristic intensity of the contact from an intensity below the deep press intensity threshold to an intensity above the deep press intensity threshold is sometimes referred to as a “deep press” input. An increase of characteristic intensity of the contact from an intensity below the contact-detection intensity threshold to an intensity between the contact-detection intensity threshold and the light press intensity threshold is sometimes referred to as detecting the contact on the touch-surface. A decrease of characteristic intensity of the contact from an intensity above the contact-detection intensity threshold to an intensity below the contact-detection intensity threshold is sometimes referred to as detecting liftoff of the contact from the touch-surface. In some embodiments the contact-detection intensity

US 2016/0202865 A1

Jul. 14, 2016

16

threshold is zero. In some embodiments, the contact-detection intensity threshold is greater than zero.

[0192] In some embodiments described herein, one or more operations are performed in response to detecting a gesture that includes a respective press input or in response to detecting the respective press input performed with a respective contact (or a plurality of contacts), where the respective press input is detected based at least in part on detecting an increase in intensity of the contact (or plurality of contacts) above a press-input intensity threshold. In some embodiments, the respective operation is performed in response to detecting the increase in intensity of the respective contact above the press-input intensity threshold (e.g., a “down stroke” of the respective press input). In some embodiments, the press input includes an increase in intensity of the respective contact above the press-input intensity threshold and a subsequent decrease in intensity of the contact below the press-input intensity threshold, and the respective operation is performed in response to detecting the subsequent decrease in intensity of the respective contact below the press-input threshold (e.g., an “up stroke” of the respective press input).

[0193] In some embodiments, the device employs intensity hysteresis to avoid accidental inputs sometimes termed “jitter,” where the device defines or selects a hysteresis intensity threshold with a predefined relationship to the press-input intensity threshold (e.g., the hysteresis intensity threshold is X intensity units lower than the press-input intensity threshold or the hysteresis intensity threshold is 75%, 90%, or some reasonable proportion of the press-input intensity threshold). Thus, in some embodiments, the press input includes an increase in intensity of the respective contact above the press-input intensity threshold and a subsequent decrease in intensity of the contact below the hysteresis intensity threshold that corresponds to the press-input intensity threshold, and the respective operation is performed in response to detecting the subsequent decrease in intensity of the respective contact below the hysteresis intensity threshold (e.g., an “up stroke” of the respective press input). Similarly, in some embodiments, the press input is detected only when the device detects an increase in intensity of the contact from an intensity at or below the hysteresis intensity threshold to an intensity at or above the press-input intensity threshold and, optionally, a subsequent decrease in intensity of the contact to an intensity at or below the hysteresis intensity, and the respective operation is performed in response to detecting the press input (e.g., the increase in intensity of the contact or the decrease in intensity of the contact, depending on the circumstances).

[0194] For ease of explanation, the descriptions of operations performed in response to a press input associated with a press-input intensity threshold or in response to a gesture including the press input are, optionally, triggered in response to detecting either: an increase in intensity of a contact above the press-input intensity threshold, an increase in intensity of a contact from an intensity below the hysteresis intensity threshold to an intensity above the press-input intensity threshold, a decrease in intensity of the contact below the press-input intensity threshold, and/or a decrease in intensity of the contact below the hysteresis intensity threshold corresponding to the press-input intensity threshold. Additionally, in examples where an operation is described as being performed in response to detecting a decrease in intensity of a contact below the press-input intensity threshold, the operation is, optionally, performed in response to detecting a

decrease in intensity of the contact below a hysteresis intensity threshold corresponding to, and lower than, the press-input intensity threshold.

[0195] Attention is now directed to various exemplary embodiments of techniques for coordinating movements of an electronic document displayed on a display with one or more objects contained therein as they undergo various different animation effects such as scrolling and rubber-banding.

[0196] 1. Coordination of Movement Behaviors of Electronic Document and Objects

[0197] FIGS. 5A-5F illustrate an example of coordinated movements of an electronic document and an object of a first type (e.g., object 510) contained therewithin. FIGS. 5G-5K illustrate an example of coordinated movements of an electronic document and an object of a second type (e.g., object 530) contained therewithin. FIGS. 5L-5P illustrate an example of coordinated movements of an electronic document and an object of a fourth type (e.g., object 550) contained therewithin. FIGS. 5Q-5R illustrate another example of coordinated movements of an electronic document and an object of a first type (e.g., object 510) contained therewithin. All of these drawings illustrate examples of coordinated movements of a respective electronic document and an object of a third type (e.g., objects 514 and/or 512) contained therewithin.

[0198] FIG. 5A illustrates electronic device 500 with touch-sensitive display 502. On display 502, window 504 is displayed in a full screen mode. In a regular mode, window 504 is displayed in a portion of display 502. Window 504 contains URL bar 507, menu bar 508, and/or content window 506 (e.g., a box below menu bar 508) for displaying at least a portion of electronic document 505. Optionally, URL bar 507 contains an address associated with electronic document 505 (e.g., a webpage). Optionally, menu bar 508 contains various menu items such as, non-exclusively, File, Edit, View, Favorites, Tools and Help. Optionally, menu bar 508 and/or URL bar 506 are hidden from display (e.g., not displayed), or the display appearances of these fields are changed manually in response to an input from a user and/or automatically based on various factors predetermined in the system (e.g., display properties, display orientation, properties of electronic document 505).

[0199] In some embodiments, electronic document 505 is a webpage. Optionally, electronic document 505 is displayed on display 502 using one or more applications installed on device 500 (e.g., web-browsers, Finder™ developed by Apple, Inc. in Cupertino, Calif.).

[0200] In some embodiments, electronic document 505 has a predefined shape and includes one or more content boundaries. In FIG. 5A, electronic document 505 has a rectangular shape and thus contains four content boundaries—the first content boundary at the top edge of electronic document 505 (e.g., an edge of electronic document 505 above upper window edge 506-a), the second content boundary at the bottom edge of electronic document 505 (e.g., an edge of electronic document 505 below the edge of the window 506-b), the third content boundary at the right edge of electronic document 505 (e.g., an edge of electronic document 505 on or to the right of the edge of the window 506-c), and the fourth content boundary at the left edge of electronic document 505 (e.g., an edge of electronic document 505 on or to the left of window edge 506-a).

US 2016/0202865 A1

Jul. 14, 2016

17

[0201] In some embodiments, although the electronic document has a rectangular shape having four boundaries on the four edges, the device recognizes a select number of the boundaries as the content boundaries to be used in the movement coordination system in response to a scroll input. For example, only the content boundaries of the electronic document that are in the direction(s) in which the electronic document is scrolled are recognized as the content boundaries for use in the system (e.g., the top and bottom content boundaries if the electronic document is scrolled in the vertical direction, and the right and left content boundaries if the electronic document is scrolled in the horizontal direction).

[0202] In FIG. 5A, the displayed portion of the electronic document 505 does not contain the top content boundary of the electronic document 505 (e.g., there is more content beyond window edge 506-a that can be scrolled down to be within inside content window 506). The displayed portion of the electronic document 505 does not contain the bottom content boundary of the electronic document 505 (e.g., there is more content below the edge of the window 506-b that can be scrolled up to be within inside content window 506). The right-side content boundary of the electronic document is on or near the right edge of the window 506-c, and the left-side content boundary of the electronic document is on or near the left edge of the window 506-d.

[0203] In FIG. 5A, the electronic document 505 includes object 510 of the first type, objects 512 and 514 of the third type and a background (a dotted background in electronic document 505 displayed underneath the objects). Optionally, the objects contained within the electronic document are one or more of user interface objects, graphical objects, text blocks, images, data containers where the data contained is received from an external device and is updated in real-time (e.g., advertisement banners), user interfaces that are activated to cause device 500 to perform associated functions (e.g., touch-activated user interface objects), etc.

[0204] In FIG. 5A, while device 500 is displaying the portion of the electronic document 505 with object 510 of the first type and objects 512 and 514 of the third type, an input is detected that corresponds to a request to translate the electronic document 505 in a first direction. Optionally, the request is a request to scroll the electronic document in the first direction.

[0205] In FIG. 5A, the detected input that corresponds to a request to translate the electronic document 505 in a first direction includes an initial finger contact with the touch-sensitive display at 520-a and subsequent continuous movement of the finger contact in direction 522. This finger contact followed by the continuous movement is recognized as a request to translate the electronic document 505 in the same direction of the movement of the contact (the downward direction 522 in FIG. 5A).

[0206] Optionally, the detected input that corresponds to a request to translate the electronic document 505 in a first direction includes, non-exclusively, a stylus input, a mouse input, a hand-motion input, a face-motion input, an eye-movement input, and/or other bodily part motion input, etc. Optionally, the device determines that the first direction in which the translation of the electronic document is requested (e.g., the downward direction in FIG. 5A) is the same direction in which the detected input is moved (e.g., direction 522 in FIG. 5A). Optionally, the device determines that the first direction in which the translation of the electronic document is requested is not the same direction as the direction in which

the detected input is moved. For example, a user swipes to the left, and the device interprets the detected swipe as a request to translate the electronic documents in the rightward direction. Optionally, the correlation between the detected input and the translation request is based on, non-exclusively, setting preferences of the application being used to display the electronic document on display 502, types of input mechanism used to provide the input that corresponds to a translation request, characteristics of the displayed electronic document, etc.

[0207] In FIG. 5B, in response to detecting the input that corresponds to a request to translate the electronic document 505 in direction 522 (finger movement from 520-a to 520-b), a respective portion of the electronic document 505 is translated in direction 522 in accordance with the detected input. The respective portion of the electronic document 505 that is translated in accordance with the detected input includes the background of the electronic document 505 and content boundary 505-a. Optionally, the respective portion of the electronic document includes one or more components of the electronic document including objects (e.g., text blocks, images, content boxes in a structured document). The respective portion of an electronic document optionally includes CSS position-fixed objects (e.g., for an electronic document of web content). In some embodiments, different electronic documents have different components of the document as the respective portion to be treated as having fixed positions relative to the content boundaries of the electronic document. Optionally, the respective portion of the electronic document includes parts that are not continuous with each other and, optionally includes, for example, one or more continuous or non-continuous portions of the background of the document and continuous or non-continuous portions of the contents of the electronic document.

[0208] The third-type objects 512 and 514 are translated with the respective portion of the electronic document 505. These objects are translated as having fixed positions relative to content boundaries of the electronic document. When implemented, these objects are, optionally, designated as part of the respective portion of the electronic document, or, optionally, coded as separate objects that behave in a similar manner as the respective portion of the electronic document. While the third-type objects are translated along with the respective portion of the electronic document 505, the first-type object 510 does not move and remains stationary relative to the edge(s) of the display window (e.g., 506-a, 506-b, 506-c, 506-d) as the respective portion of the electronic document 505 is translated in the downward direction.

[0209] For example, as the third-type objects 512 and 514 are translated in the downward direction along with the background of the electronic document in accordance with the input, the upper portion of object 514, which was not previously displayed, is now displayed as it is translated in the downward direction to be within inside content window 506. Also, object 512 is moved down closer to the bottom edge of the window 506-b.

[0210] In some embodiments, the amount by which each individual component of the respective portion of the electronic document is translated in accordance with the input is consistent—the distance moved by object 512 is the same as the distance moved by object 514, and the same amount is moved by the background of the electronic document 505. For example, objects 514 and 512 are translated as if they are fixed in respective locations in the background of the elec-



US 2016/0202865 A1

Jul. 14, 2016

18

tronic document (e.g., fixed relative to the content boundaries of the electronic document). Optionally, the amount by which each individual component of the respective portion of the electronic document is translated in accordance with the input varies, for example, to maintain the display ratio, etc. For example, while objects **512** and **514** are both translated in accordance with the input, object **514** is translated by a greater or smaller amount than the amount by which object **512** is translated from the same input.

[0211] In some embodiments, the amount of the translation performed by the respective portion of the electronic document **505** has a linear relationship with the input (e.g., the magnitude of the input). For example, in FIG. 5B, the input is the contact movement from **520-a** to **520-b**, and the distance between **520-a** and **520-b** has a linear relationship with the distance translated by the respective portion of the electronic document **505**. In some embodiments, the linear relationship is a proportional relationship (e.g., a direct proportional relationship). Optionally, the linear relationship between the input and the amount of the translation caused by the input is predefined. Optionally, the linear relationship between the input and the amount of the translation caused by the input is dynamically determined based on, for example, a speed associated with the input, types of input (e.g., touch input, mouse input), overall length of the electronic document, etc.

[0212] In some embodiments, the speed of the translation of the respective portions of the electronic document that are translated in accordance with the input has a linear relationship with the speed associated with the input. For example, in FIG. 5B, if the user moves the finger contact from **520-a** to **520-b** at a first speed, the respective portions of the electronic document **505** are translated at a speed that has a linear relationship with the first speed. If the user moves the finger contact from **520-a** to **520-b** at a second speed faster than the first speed, the respective portions of the electronic document **505** are translated at a speed that has a linear relationship with the second speed and is faster than the first speed.

[0213] While the respective portions of the electronic document **505** (including the background and content boundary **505-a**) are translated in accordance with the input, the object of the first type (object **510**) does not move. For example, object **510** remains stationary relative to the edge(s) of the window **506**. In FIG. 5B, object **510** has remained stationary in a fixed location relative to the edge(s) of the window including **506-a**—e.g., the distance between the top edge of the window **506-a** and object **510** has remained the same in FIGS. 5A and 5B while the positions of objects **512** and **514** relative to the top edge of the window **506-a** have changed.

[0214] In FIG. 5B, in accordance with the detected input of the finger contact movement from **520-a** to **520-b**, the top content boundary of the electronic document **505-a** (not yet shown in FIG. 5B but shown in FIG. 5C) as it has not yet reached the top edge of the window **506-a**, but has been pulled closer to window edge **506-a**. If the user continues to further move the finger contact down to **520-c** as shown in FIG. 5C, the top content boundary of the electronic document **505-a** reaches the top edge of the window **506-a**.

[0215] In FIG. 5C, in accordance with the detected input of the further finger contact movement from **520-b** to **520-c**, the top content boundary of the electronic document **505-a** has reached the top edge of the window **506-a**. In so doing, the respective portions of the electronic document, including content boundary **505-a** and the background, as well as the third-type objects **512** and **514**, are translated in the down-

ward direction in accordance with the further contact movement from **520-b** to **520-c**, while the first-type object **510** has remained stationary, as shown in FIG. 5C.

[0216] In some embodiments, as the respective portions of the electronic document **505** are translated, a part of such portions (a portion of the background in FIGS. 5B-5C) is translated under the first-type object that remains stationary. For example, the part of the background of the electronic document **505** that becomes directly under object **510** as it is translated in the downward direction in accordance with the finger movement is moved by passing under the object **510**. Optionally, the part of the background that is translated under object **510** is at least partially visible through object **510** from underneath.

[0217] In FIG. 5D, the user continues to further move the finger contact from **520-c** to **520-d** so that the top content boundary of the electronic document **505-a** is pulled inside window edge **506-a**. The respective portions of the electronic document, including the background and content boundary **505-a**, are also pulled in the downward direction in accordance with this further finger movement from **520-c** to **520-d** (as well as the objects **512** and **514** of the third type) while the first-type object **510** remains stationary. As shown in the illustrated example, as the top content boundary **505-a** is pulled down sufficiently inside window edge **506-a** with object **510** being stationary, the object **510** becomes positioned outside the content boundary **505-a**.

[0218] In some embodiments, the translation behavior of the respective portion of the electronic document (e.g., content boundary **505-a** and the background) and objects **512** and **514** of the third type, is performed in a first relationship with the finger movement (finger movement from **520-a** to **520-c**) until content boundary **505-a** reaches window edge **506-a**. After the content boundary **505-a** has reached window edge **506-a** and as the content boundary **505-a** is pulled inside the window edge, the translation behavior of the respective portion of the electronic document (e.g., content boundary **505-a** and the background) and objects **512** and **514** of the third type, is performed in a second relationship different than the first relationship with the finger movement (finger movement from **520-c** to **520-d**). Optionally, the first relationship includes the amount of the translation having a linear relationship with the amount of the finger movement, and the second relationship includes the amount of the translation having a non-linear relationship with the amount of the finger movement. Optionally, the first relationship includes the speed of the translation having a linear relationship with the speed of the finger movement, and the second relationship includes the speed of the translation having a non-linear relationship with the speed of the finger movement.

[0219] In some embodiments, the non-linear relationship is a relationship that simulates behaviors of an elastic material—for example, the amount of the input simulating a force being applied on an elastic material for stretching, and the respective portion of the electronic document to be translated in accordance with the input simulating the elastic material being stretched from the force. Optionally, gap area **505-G**, which has been created between the pulled content boundary **505-a** and window edge **506-a**, is simulated to be the elastic material that stretches in accordance with the force, e.g., contact movement from **520-c** to **520-d**. Optionally, the movement behavior of the respective portion of the electronic document as the content boundary **505-a** is pulled inside window edge **506-a** is simulated to be the behavior of a rubber

US 2016/0202865 A1

Jul. 14, 2016

19

band or a spring that has a predefined elasticity or a spring coefficient. Optionally, the simulated behavior includes the elastic material being stretched upon application of a force and does not deform regardless of the magnitude of the force. Upon release of the force (e.g., a liftoff of the contact), the simulated elastic material returns to an equilibrium position. The equilibrium position, in the illustrated examples, is the position in which the content boundary **505-a** lies on or near window edge **506-a** (as shown in FIGS. **5C** and **5F**). Optionally, the equilibrium position is a point at which the movement behavior of the electronic document switches between having a linear relationship with the scroll input and having a non-linear relationship with the scroll input.

[0220] In some embodiments, the equilibrium position changes depending on characteristics of the input that has caused the non-linear translation behavior. For example, depending on the direction, position, magnitude, orientation, etc., of the finger movement, the equilibrium position varies to different positions (e.g., content boundary that was previously pulled inside the edge of the window is outside or inside the edge of the window by a predefined amount, etc.).

[0221] As will be apparent to those skilled in the art, there are various ways to simulate a behavior of an elastic material like a spring or a rubber band, for example, with the input representing a force applied to an elastic material, and the amount translated by the respective portions of the electronic document representing an amount stretched by the elastic material from the force. Optionally, a mathematic formula representing a linear elasticity is used—e.g.,  $F = -kx$ , where  $x$  represents the displacement (e.g., the amount of translation),  $k$  represents a spring constant (e.g., which is a predefined value, or a value that changes dynamically depending on the speed, position, and/or orientation of the scroll input), and  $F$  represents the force (e.g., the input, the distance moved by the finger). Optionally, the non-linear relationship includes a logarithmic relationship to simulate an elastic behavior of the translation based on the input.

[0222] In some embodiments, the speed of the translation by the respective portions of the electronic document in accordance with the finger movement from **520-a** to **520-c** until the content boundary reaches the edge of the window has a linear relationship with the speed of the finger movement from **520-a** to **520-c**. On the other hand, the speed of the translation by the respective portions of the electronic document in accordance with the finger movement from **520-c** to **520-d** after the content boundary has reached the edge of the window and as the content boundary is pulled inside the edge of the window has a non-linear relationship with the speed of the finger movement from **520-c** to **520-d**.

[0223] In some embodiments, there is a predefined upper limit for the size of the gap **505-G** (e.g., the length of the gap in the direction in which the content boundary is translated). The size of the gap **505-G** increases in accordance with the finger movement but stops increasing despite the continued finger movement after the size of the gap **505-G** has reached the upper limit. For example, the content boundary **505-a** continues to be pulled further inside window edge **506-a** in accordance with the finger movement, but after the content boundary **505-a** has reached the maximum amount that it can be pulled inside the edge of the window, it stops being pulled further down despite the continued finger movement.

[0224] Referring back to FIG. **5C**, as the content boundary **505-a** is pulled inside window edge **506-a**, a gap is created between the content boundary and the edge of the window as

shown in area referred to as **505-G** in FIG. **5D**. The size of this gap area increases as the content boundary **505-a** is pulled further inside window edge **506-a**. The first-type object **510** that remains stationary and becomes outside the content boundary **505-a** is displayed in the gap area **505-G**.

[0225] In FIG. **5E**, the user releases the contact at **520-d**. In response to detecting the release of the contact, the respective portion of the electronic document that has been translated in accordance with the finger movement returns to the equilibrium position where the content boundary **505-a** is on window edge **506-a**, as shown in FIG. **5F**. Optionally, this return movement occurs without further user intervention (e.g., the respective portion of the document bounces back automatically upon detection of the release of the contact). Optionally, during the return movement, the respective portion of the electronic document, including content boundary **505-a** and the background, is translated in the second direction (**524**), which is opposite the direction in which the electronic document was previously translated in response to the finger movement, until the content boundary **505-a** reaches window edge **506-a** (FIG. **5F**). The objects **512** and **514** of the third type are, optionally, translated in the same manner as the respective portion of the electronic document. The objects **512** and **514** are, optionally, treated as part of the respective portion of the electronic document.

[0226] In some embodiments, the return movement to the equilibrium position is triggered by the detection of the release of the contact, as shown in FIG. **5E**. Optionally, the return movement is triggered by the detection of the end of the scroll input (e.g., a user stops dragging but keeps the contact on the display). Optionally, the return movement is not triggered from the detection of the end of the scroll input if the gesture that provided the scroll input does not completely come to an end (e.g., no longer detected). For example, if the user stops dragging but still maintains the contact on the display, the electronic document is kept stationary at the position at which the document was previously pulled from the user's dragging gesture and does not initiate a return movement until after the liftoff of the contact is detected. Optionally, the return movement is triggered by ceasing to detect the input that provided the scroll input such as, non-exclusively, ceasing to detect a mouse input, a hand-motion input, a motion input of any other bodily parts, a stylus input, and any other mechanical or physical inputs that were at least partially recognized as the scroll input.

[0227] Referring to FIG. **5E**, during the return movement, content boundary **505-a** is translated in the second direction after the end of the input, and, thus, the size of the gap **505-G** reduces until the gap is completely removed as content boundary **505-a** reaches window edge **506-a** (FIGS. **5E-5F**). As content boundary **505-a** is translated in the second direction (in the upward direction in FIGS. **5E-5F**), first-type object **510** returns to be inside content boundary **505-a**.

[0228] In some embodiments, the return movement is simulated to be a restoring behavior of an elastic material after the force that was previously applied to stretch the material stops being applied (e.g., stops being detected). For example, the gap area **505-G** that is created as content boundary **505-a** is pulled inside the edge of the window **506-a** is simulated to behave as an elastic material (e.g., a rubber band or spring) that does not undergo a deformation regardless of the magnitude of the force (e.g., amount of the finger movement). After the detection of the liftoff of the contact, the lower end of the gap **505-G** (e.g., content boundary **505-a**)

US 2016/0202865 A1

Jul. 14, 2016

20

returns to the equilibrium position as if the rubber band or spring is let go after being stretched from the pulling force. The equilibrium position is the position in which the lower end of the gap 505-G substantially coincides with its upper end at window edge 506-a.

[0229] In some embodiments, the speed of the return movement in the second direction after the end of the input is performed at a speed faster than a speed at which the respective portions of the electronic document were previously translated in accordance with the input. Optionally, the return movement in the second direction is performed at a predetermined speed. Optionally, the return movement in the second direction is performed at a varying speed so as to be completed in a predefined time period regardless of how deep inside the edge of the window was the content boundary previously pulled (e.g., completed in 0.1 sec., 0.2 sec., 0.3 sec, 0.4 sec, 0.5 sec, etc.).

[0230] The various features described above with reference to FIGS. 5A-5F are optional, and any one or more of these features can be removed, modified, or combined with any other features described herein with reference to other figures (e.g., FIGS. 5G-5T and FIGS. 6A-6K), as will be apparent to those skilled in the art. For brevity, such modifications and permutations are not repeated for every subsequent example described below but are deemed within the scope of the present disclosure.

[0231] FIGS. 5G-5K illustrate an example of coordinated movements of an electronic document and an object of a second type (e.g., object 530) contained therewithin. FIG. 5G illustrates an electronic device with a touch-sensitive display. On the display, an electronic document 535 is displayed in content window 506. The electronic document 535 contains objects 512 and 514 of the third type and object 530 of the second type. The behaviors of the third-type objects are similar to those explained above with reference to FIGS. 5A-5F.

[0232] In FIG. 5G, the user provides an input that corresponds to a request to translate the electronic document in the first direction by making an initial finger contact at 540-a and continuously moving the finger contact in direction 542. This input is recognized as a request to translate the electronic document 535 in direction 542, and in response to detecting this input device 500 translates respective portions of electronic document 535 in direction 542 in accordance with the detected input.

[0233] In FIG. 5H, in accordance with the detected input (e.g., the downward finger movement from 540-a to 540-b), the respective portion of the electronic document 535, including content boundary 535-a and the background, is translated in the downward direction. The objects 512 and 514 of the third type are translated with the respective portion of the electronic document. In comparison, the second-type object 530 does not move and remains stationary relative to the edge(s) of the window. The object 530 remains stationary until the content boundary 535-a reaches window edge 506-a and starts being translated with the respective portions of the electronic document 535, once the content boundary 535-a has passed window edge 506-a and as the content boundary 535-a is pulled inside window edge 506-a. Optionally, the object 530 remains stationary relative to the edges of the window while the respective portions of the electronic document 535 are translated. This causes at least a part of the respective portions (a part of the background that is directly under the second object 530 in FIGS. 5G-5H) to be translated under the object 530. Optionally, the part of the respective

portions that is passed under the object 530 is at least partially visible through the object 530 from underneath.

[0234] For example, the second-type object 530 remains stationary in a fixed position relative to one or more edges of the content window (e.g., 506-a, 506-b, 506-c, and/or 506-d) while the respective portions of the electronic document 535 are translated in accordance with the input (finger movement from 540-a to 540-b) until the content boundary 535-a reaches window edge 506-a. The second-type object 530 then starts being translated along with the respective portions of the electronic document 535 in accordance with the input after the content boundary passes window edge 506-a and as the content boundary is pulled inside window edge 506-a from the input, as shown in FIG. M.

[0235] In FIG. 5I, as the content boundary 535-a passes and is pulled inside window edge 506-a in accordance with the finger movement from 540-b to 540-c, the object 530 is translated with the respective portions of the electronic document 535, although the object 530 has remained stationary in response to the finger movement from 540-a to 540-b. Optionally, the object 530 of the second type has a fixed position relative to the edge(s) of the content window (e.g., 506-a, 506-b, 506-c, and/or 506-d) before the content boundary 535-a of the electronic document 535 reaches window edge 506-a. Furthermore, object 530 of the second type has a fixed position relative the edges(s) of the electronic document 535 (the content boundaries of the electronic document 535) after the content boundary 535-a has reached window edge 506-a and as the content boundary 535-a is pulled inside window edge 506-a. The translation of the respective portions of the electronic document 535 has a linear relationship with the input until the content boundary 535-a reaches window edge 506-a, and the translation of the respective portions of the electronic document 535 and the object 530 has a non-linear relationship with the input after the content boundary 535-a has reached window edge 506-a and as it is pulled inside the edge of the window. The various characteristics of such behaviors are explained with reference to FIGS. 5A-5F and will not be repeated here, for brevity.

[0236] Referring to FIG. 5I, as the content boundary 535-a is pulled inside the edge 506-a of the window, gap 535-G is created therebetween. The size of this gap increases as the content boundary 535-a is pulled further inside the edge of the window. In FIG. 5J, the user releases the contact at 540-c. In response to detecting the release of the contact (or, optionally, the end of the scroll input), the respective portions of the electronic document 535 and the object 530 return to the equilibrium position. The equilibrium position is the position in which the content boundary 535-a is translated in the second direction (upward direction 544 in FIG. 5J) to be on or approximately near window edge 506-a. The second object 530 is subject to the same restoration behavior as the respective portions of the electronic document 535, including the background and content boundary 535-a. The objects 512 and 514 of the third type are also translated with the respective portion of the electronic document 535 during the restoring behavior. After the restoration is complete, the content boundary 535-a is back on window edge 506-a, and the objects 514, 512 and 530 are returned to their respective positions as shown in FIG. 5K. Such restoring movement occurs without further user intervention (e.g., the pulled portions of the document bounce back automatically to return to the equilibrium position). The details of the restoration



US 2016/0202865 A1

Jul. 14, 2016

21

behavior are explained with reference to FIGS. 5D-5F and will not be repeated here, for brevity.

[0237] The various features described above with reference to FIGS. 5G-5K are optional, and any one or more of these features can be removed, modified, or combined with any other features described herein with reference to other figures (e.g., FIGS. 5A-5F, FIGS. 5K-5T, and FIGS. 6A-6K), as will be apparent to those skilled in the art. For brevity, such modifications and permutations are not repeated but are deemed within the scope of the present disclosure.

[0238] FIGS. 5L-5P illustrate an example of coordinated movements of an electronic document and an object of a fourth type (e.g., object 550) contained therein. FIG. 5L illustrates an electronic device with a touch-sensitive display. On the display, an electronic document 555 is displayed in content window 506. The electronic document 555 contains object 512 of the third type, object 530 of the second type, and object 550 of the fourth type.

[0239] In FIG. 5L, the user provides an input that corresponds to a request to translate the electronic document 555 in a first direction by making an initial finger contact at 560-a and continuously moving the finger contact in direction 562. This input is recognized as a request to translate the electronic document 555 in direction 562, and in response to detecting this input, the device translates respective portions of the electronic document 555 in direction 562 in accordance with the input (as shown in FIG. 5M).

[0240] In FIG. 5M, in accordance with the downward finger movement from 560-a to 560-b, the respective portion of the electronic document 555, including the background and content boundary 555-a, is translated in direction 562. The object 512 of the third-type is also translated with the respective portion of the electronic document 555. The object 550 of the fourth type is also translated along with the respective portions of the electronic document 555 in accordance with the finger movement from 560-a to 560-b until the content boundary 555-a reaches window edge 506-a. The object 530 of the second type, as explained above, remains stationary before the content boundary 555-a reaches window edge 506-a.

[0241] As shown in FIG. 5M, when the finger is moved to 560-b, the content boundary 555-a reaches window edge 506-a. At this point, the object 550 of the fourth type remains stationary despite the further finger movement, and the object 530 of the second type begins to be translated along with the respective portions of the electronic document 555, including the content boundary 555-a and background (as shown in FIG. 5N). The object 512 of the third type is translated with the respective portion of the electronic document 555. Specifically, in FIG. 5N, the object 550 remains stationary while the respective portions of the electronic document 555 (the background, content boundary 555-a) and object 512 of the third type and object 530 of the second type, are translated in the downward direction in accordance with the finger movement from 560-b to 560-c.

[0242] In some embodiments, the objects 550 of the fourth type is fixed relative to the edges of the electronic document 555 (content boundaries of the electronic document 555) before the content boundary 555-a reaches window edge 506-a; and the objects 550 of the fourth type is fixed relative to the edges of the window 506 after the content boundary 555-a reaches window edge 506-a and as the content boundary 555-a is pulled inside window edge 506-a. The translation of the respective portions of the electronic document 555 and

object 550 has a linear relationship with the input until the content boundary 555-a reaches window edge 506-a (FIGS. 5L and 5M). After that, the translation of the respective portions of the electronic document 555 and the object 530 has a non-linear relationship with the input after content boundary 555-a has reached window edge 506-a, and as the content boundary is pulled inside window edge 506-a (FIG. 5N). The various characteristics of such behaviors are explained with reference to FIGS. 5A-5F and will not be repeated here, for brevity.

[0243] In FIG. 5O, the user releases the contact at 560-c. Upon detection of the release of the contact (or, optionally, the end of the scroll input), the respective portions of the electronic document 555 (the background and content boundary 555-a) and objects 512 and 530, are translated in the upward direction (direction 564) while the object 550 continues to remain stationary. In some embodiments, the object 530 of the second type remains stationary as the user moves the finger from 560-a to 560-b (FIGS. 5L and 5M) but starts being translated in accordance with the user's finger movement from 560-b to 560-c (FIG. 5N). The object 512 of the third type is translated in accordance with the finger movement, both in response to the finger movement from 560-a to 560-b (FIGS. 5L and 5M) and the finger movement from 560-b to 560-c (FIG. 5N). The object 550 of the fourth type is translated in accordance with the user's finger movement from 560-a to 560-b (FIGS. 5L and 5M) but remains stationary in response to the user's finger movement from 560-b to 560-c (FIG. 5N). The object 550 of the fourth type remains stationary even if that means that the object 550 is outside the content boundary 555-a, as shown in FIG. 5N, as the content boundary 555-a is pulled under and out of the object 550.

[0244] In some embodiments, as shown in FIGS. 5N and 5O, the content boundary 555-a and portions of the background of the electronic document 555 are passed under the object 550 as those are translated in the downward and upward directions in accordance with the finger movement or the restoration behavior. Optionally, the content boundary 555-a and the portions of the background that becomes under the stationary object 550 are at least partially visible through the object 550 from underneath.

[0245] As shown in FIG. 5N, as the content boundary 555-a is pulled inside the top edge 506-a of the window, gap 555-G is created therebetween. The size of this gap increases as the content boundary 555-a is pulled further inside the edge of the window. In FIG. 5O, the user releases the touch contact at 560-c. In response to detecting the release of the contact, which is recognized as the end of the input, the respective portions of the electronic document 555, which have been pulled down in accordance with the finger movement from 560-b to 560-c, return to the equilibrium position. The equilibrium position is the position in which the content boundary 555-a is translated in the second direction (upward direction 564 in FIG. 5O) to be on or approximately near window edge 506-a. The second-type object 530 and third-type object 512 are subject to the same restoration behavior as the respective portions of the electronic document 555, including the background and content boundary 555-a. As the restoration behavior is carried out, the size of the gap 555-G is reduced accordingly. After the restoration is complete, the content boundary 555-a is on window edge 506-a, and the objects 514, 512 and 530 are returned to their respective positions, as shown in FIG. 5P. The fourth-type object 550 is not subject to the restoration behavior and remains stationary during the

US 2016/0202865 A1

Jul. 14, 2016

22

restoration movement of the respective portions of the electronic document 555 and objects 512, 514 and 530, as shown in FIGS. 5O and 5K. The details of the restoration behavior are explained with reference to FIGS. 5D-5F and will not be repeated here, for brevity.

**[0246]** The various features described above with reference to FIGS. 5L-5P are optional, and any one or more of these features can be removed, modified, or combined with any other features described herein with reference to other figures (e.g., FIGS. 5A-5K, FIGS. 5Q-5T, and FIGS. 6A-6K), as will be apparent to those skilled in the art. For brevity, such modifications and permutations are not repeated but are deemed within the scope of the present disclosure.

**[0247]** In some embodiments, an electronic document includes any combination of one or more of first type objects (e.g., object 510), second type objects (e.g., object 530), third type objects (e.g., objects 512 and 514), and fourth type objects (e.g., object 550). The characteristics of each of these types of objects optionally include the following:

**[0248]** The first-type objects such as object 510 (e.g., a toolbar, a menu bar, a background of a webpage) in an electronic document remains stationary (e.g., in a fixed position relative to edge(s) of the content window 506) at all relevant times of the translation—including (i) when a respective portion of the electronic document is translated in accordance with the input (e.g., a request to translate the document in a first direction, a scroll input) before the content boundary of the electronic document reaches the edge of the window; (ii) when the respective portion of the electronic document is translated in accordance with the input after the content boundary has reached the edge of the window and as the content boundary is pulled inside the edge of the window; and (iii) when the respective portion of the electronic document is translated after the end of the input to restore the position of the content boundary to an equilibrium position.

**[0249]** Optionally, the first-type objects have fixed positions relative to the edge(s) of the window regardless of whether the amount of the translation of the respective portion of the electronic document has a linear or non-linear relationship with the input.

**[0250]** The second type objects such as object 530 (e.g., a banner, a pop-up, a content box of a webpage) in an electronic document remains stationary (e.g., in a fixed position relative to edge(s) of the content window 506) when a respective portion of the electronic document is translated in accordance with the input (e.g., a request to translate the document in a first direction, a scroll input) before the content boundary of the electronic document reaches an edge of the window. But, the second-type objects are translated in accordance with the input (e.g., becomes to be in a fixed position relative to content boundaries of the electronic document) (ii) when the respective portion of the electronic document is translated in accordance with the input after the content boundary has reached the edge of the window and as the content boundary is pulled inside the edge of the window; and (iii) when the respective portion of the electronic document is translated after the end of the input to restore the position of the content boundary to an equilibrium position.

**[0251]** Optionally, the second-type objects have fixed positions relative to the edge(s) of the window when the amount of the translation of the respective portion of the electronic document has a linear relationship with the input. The second-type objects have fixed positions relative to the content boundaries of the electronic document when the amount of

the translation of the respective portion of the electronic document has a non-linear relationship with the input.

**[0252]** The third-type objects such as objects 512 and 514 (e.g., content of a webpage, a text/image of a webpage, a background of a webpage) in an electronic document are translated in accordance with the input along with a respective portion of the electronic document at all relevant times of the translation—(i) when a respective portion of the electronic document is translated in accordance with the input (e.g., a request to translate the document in a first direction, a scroll input) before the content boundary of the electronic document reaches the edge of the window; (ii) when the respective portion of the electronic document is translated in accordance with the input after the content boundary has reached the edge of the window and as the content boundary is pulled inside the edge of the window; and (iii) when the respective portion of the electronic document is translated after the end of the input to restore the position of the content boundary to an equilibrium position.

**[0253]** Optionally, the third-type objects have fixed positions relative to the content boundaries of the electronic document regardless of whether the amount of the translation of the respective portion of the electronic document has a linear relationship with the input or a non-linear relationship with the input.

**[0254]** The fourth-type objects such as object 550 (e.g., content of a webpage, a text/image of a webpage, a background of a webpage) in an electronic document are translated along with a respective portion of the electronic document (e.g., having a fixed position relative to the content boundaries of the electronic document) (i) when a respective portion of the electronic document is translated in accordance with the input (e.g., a request to translate the document in a first direction, a scroll input) before the content boundary of the electronic document reaches the edge of the window. However, the fourth-type objects remain stationary (e.g., having a fixed position relative to edge(s) of the content window) (ii) when the respective portion of the electronic document is translated in accordance with the input after the content boundary has reached the edge of the window and as the content boundary is pulled inside the edge of the window; and (iii) when the respective portion of the electronic document is translated after the end of the input to restore the position of the content boundary to an equilibrium position.

**[0255]** Optionally, the fourth-type objects have fixed positions relative to the content boundaries of the electronic document when the amount of the translation of the respective portion of the electronic document has a linear relationship with the input. And, the fourth-type objects have fixed positions relative to the edge(s) of the window when the amount of the translation of the respective portion of the electronic document has a non-linear relationship with the input.

**[0256]** In some embodiments, the type of an object changes dynamically based on factors such as, non-exclusively, a display mode and a scroll direction. For example, an object behaves like an object of a certain type when the electronic document is displayed in a full-screen mode, and the same object behaves like an object of a different type when the electronic document is displayed in other modes. Alternatively or additionally, an object behaves like an object of a certain type when the scroll input is in one direction, and the same object behaves like an object of a different type when the scroll input is in another direction.

US 2016/0202865 A1

Jul. 14, 2016

23

[0257] In some embodiments, the electronic document is translated in multiple including, non-exclusively, left/right horizontal directions, up/down vertical direction, diagonal directions, 3-D directions, etc. It should be understood that the concepts of the present disclosure described above with reference to examples in FIGS. 5A-5P, which concern a downward vertical translation, are applicable to other examples involving translations in various other directions. For example, FIGS. 5Q-5R illustrate an example of an application of the concepts for a horizontal translation. In FIG. 5Q, the user provides an input that corresponds to a request to translate the electronic document 505 in the leftward direction, for example, by making an initial finger contact at 580-a and continuously moving the finger contact in direction 582. The same scroll request can be made in a variety of other ways including, non-exclusively, a mount drag, a key-input, a hand-motion, etc. The electronic document 505 includes objects 514 and 512 of the third type and object 510 of the first type.

[0258] In FIG. 5R, in response to detecting the input that is recognized as a request to translate the electronic document 505 in the leftward direction, the device translates respective portions of the electronic document 505 in the requested direction in accordance with the input (finger movement from 580-a to 580-b). The respective portions of the electronic document 505 (including the background and content boundary 505-c) and objects 512 and 514 of the third type, are translated in accordance with the finger movement from 580-a to 580-b, and the first-type object 510 remains stationary so that the content boundary 505-c is pulled under and out of the first object 510. The translation of the respective portions of the electronic document 505 has a linear relationship with the finger movement until the content boundary 505-c reaches the edge of the window 506-c, and the translation of the respective portions of the electronic document 505 has a non-linear relationship with the finger movement as the content boundary 505-c passes the edge of the window 506-c and is pulled inside the edge of the window 506-c. The details of these behaviors are explained with reference to FIGS. 5A-5F and will not be repeated here, for brevity.

[0259] Referring to FIG. 5R, as the content boundary 505-c is pulled inside the edge 506-c of the window, gap 505-H is created therebetween. The size of this gap increases as the content boundary 505-c is pulled further inside the edge of the window 506-c. When the content boundary 505-c is pulled inside the edge of the window so that object 510 is outside the content boundary, object 510 is displayed in this gap area 505-H.

[0260] In FIG. 5S, the user releases the touch contact at 580-b. In response to detecting the release of the contact (or, optionally, the end of the scroll input), the respective portions of the electronic document 505 return to the equilibrium position where the content boundary 505-c is on or near the edge of the window 506-c. As the content boundary 505-c is translated toward the edge of the window 506-c in the rightward direction (584) during the restoration behavior, the gap 505-H reduces in size accordingly and is completely removed when the content boundary 505-c reaches the edge of the window 506-c (FIG. 5T). The first-type object 510 is not subject to the restoring behavior and remains stationary so that the object 510 is within inside the content boundary 505-c as the content boundary 505-c is translated in the rightward direction, as shown in FIG. 5T. The details of the restoring behaviors are described with reference to FIGS. 5D-5F and will not be repeated here, for brevity.

[0261] The illustrated features are only exemplary, and the same concepts can be applied in a similar manner to other embodiments (e.g., involving translations in a diagonal direction, z-direction, etc., a 3-D direction), as will be apparent to those skilled in the art. Such applications and permutations are deemed within the scope of the present disclosure.

[0262] The various features described above with reference to FIGS. 5Q-5T are optional, and any one or more of these features can be removed, modified, or combined with any other features described herein with reference to other figures (e.g., FIGS. 5A-5P and FIGS. 6A-6K), as will be apparent to those skilled in the art. For brevity, such modifications and permutations are not repeated but are deemed within the scope of the present disclosure.

## [0263] 2. Extended Background

[0264] As described above, the gap is generated between the pulled content boundary and the edge of the content window (e.g., 505-G in FIG. 5D, 535-G in FIG. 5I, 555-G in FIG. 5O, and 505-H in FIG. 5R) as the user attempts to translate the electronic document beyond the edge of the document (as the content boundary is pulled inside the edge of the window). The size of the gap area increases and decreases as the content boundary is pulled further inside the edge of the window, or is translated in the opposite direction from the restoring behavior. In some embodiments, this gap is displayed as distinct from the electronic document (e.g., so that the gap area is visually separated from the content boundary or the electronic document). For example, the gap is displayed in one color (e.g., grey, white) while the background of the electronic document has a different color or unrelated pattern or image. In some embodiments, the gap is displayed with a background that is generated based on the background of the electronic document. The background that is generated for display in at least a part of the gap area is referred to hereinafter as an "additional background." Optionally, the additional background is generated so as to create a visual illusion that it is an extended part of the background actually contained in the electronic document. The descriptions below provide several examples of such applications involving the additional background for display in the gap area.

[0265] FIGS. 6A-6F illustrate an example of displaying additional background in a gap between a content boundary of an electronic document and an edge of a window. In FIG. 6A, electronic document 601 has objects 612 and 614 of the third type, object 610 of the first type, top content boundary 601-a (not shown in FIG. 6A but shown in FIG. 6B) and background 612 (a pattern of solid diagonal lines). The device 600 detects an input that corresponds to a request to translate the electronic document 601 in a first direction (e.g., a finger contact at 620 and subsequent continuous movement of the finger in direction 622, without lifting the finger).

[0266] In FIG. 6B, in accordance with the finger movement from 620-a to 620-b, respective portions of the electronic document 601 (including the background 612 and top content boundary 601-a) and third-type objects 612 and 614, are translated in the first direction (the downward direction). The translation behavior of the respective portions of the electronic document 601 has a linear relationship with the finger movement from 620-a to 620-b until the content boundary 601-a reaches the edge of the content window 606-a, as shown in FIG. 6B. The first-type object 610 remains stationary.



US 2016/0202865 A1

Jul. 14, 2016

24

[0267] In FIG. 6C, as the user continues to move the finger down from 620-b to 620-c, the respective portions of the electronic document 601 are translated in a non-linear relationship with the finger movement from 620-b to 620-c, while the first-type object 610 continues to remain stationary. As the content boundary 601-a is pulled inside the edge of the window 601-a, the gap 601-G is created between the pulled content boundary 606-a and the edge of the content window 606-a.

[0268] In FIG. 6C, the gap 601-G is displayed as distinct from the electronic document 601 (e.g., displayed with a background that is not continuous from the background 612, displayed in solid white or grey). However, in some embodiments, instead of displaying the gap 601-G as shown in FIG. 6C, the device 600 displays the gap 601-G with an additional background that is generated based on the background 612 of the electronic document 601, as shown in FIG. 6D. For example, the gap area 601-G is displayed with an additional background that has the same pattern of solid diagonal lines as in the background 612 of the electronic document 601.

[0269] In some embodiments, the additional background is created by the device 600 by matching one or more attributes of the original background 612 of the electronic document 601. The attributes of the original background of the electronic document to be used in the creation of the additional background for display in the gap area 601-G include, non-exclusively, a pattern, color, shading, pixel, resolution, orientation, image, text included or used in the original background. For example, if the original background is a solid color, the extended background is created by matching the solid color so as to create the visual effect of the newly-created additional background being an extension of the original background 612. Optionally, the visual effect causes a visual illusion that the edge of the electronic document (e.g., content boundary 601-a) is affixed to window edge 606-a even though the content boundary 601-a is actually pulled inside window edge 606-a.

[0270] In some embodiments, the original background has a specific pattern along any one or more axes (e.g., x-axis, y-axis, straight-line axis, curved-line axis, etc.), and the additional background is created by selecting a portion of the original background and replicating and/or extrapolating the pattern in the selected portion of the original background. Optionally, the selected portion of the original background is the portion of the electronic document that is near the content boundary that is pulled inside the edge of the window. For example, if the top content boundary 601-a is pulled inside the edge of the window as shown in FIGS. 6A-6D, the top portion of the original background 612 near the content boundary 601-a is selected for the generations of the additional background. Optionally, the selection process is determined so as to maximize the visual continuity between the original background and the additional background to be displayed in the gap between the content boundary and the edge of the window as the content boundary is pulled inside the edge of the window.

[0271] In some embodiments, the device retrieves relevant information about the original background from the electronic document itself or any related documents (e.g., CSS documents), or requests for such information from an external device, and upon receipt, uses the retrieved information to create the additional background. For example, the original background has a numerically defined gradient, the information about which is retrieved by the device 600 to create the

additional background. The device obtains the gradient-defining information (e.g., a formula, a computer code) and extends and/or extrapolates the gradient in the additional background using the obtained information.

[0272] In some embodiments, the device 600 creates the additional background by matching every attribute of the original background. Optionally, the device 600 does not match every attribute of the original background in the additional background and instead matches a select set of attributes of the original background. Optionally, the set of the attributes to be matched in the additional background is dynamically selected based on various factors (e.g., relating to the scroll input, the display, the electronic document). For example, the original background has a gradient in the x-axis and another gradient in the y-axis, the device determines which gradient to be used in creating the additional background (e.g., based on the direction of the scroll input, orientation, size and/or shape of the gap area to be at least partially filled in with the additional background). Further, when the original background includes an image file, the device uses a first set of attributes (e.g., pixels, resolution) of the original background to be replicated and/or extrapolated in the additional background. When the original background has a numerically-defined gradient, the device uses a second set of attributes (e.g., pattern, gradient) of the original background, which are different from the first set of attributes, to be replicated and/or extrapolated in the additional background.

[0273] Optionally, the set of attributes of the original background to be matched in the additional background is predetermined. For example, the device stores a list of attributes (e.g., color, pattern, orientation) to be used in creating the additional background, and any other attributes of the original background outside those in the list (e.g., transparency, resolution) are not matched in the additional background.

[0274] In some embodiments, the additional background is created after the device detects an input that causes the content boundary to be pulled inside the window edge, thereby creating the gap area. Optionally, the additional background is created before the gap is created so that the additional background is ready for display once the gap is displayed on the display.

[0275] In some embodiments, when the device is triggered to create the additional background, the device creates the additional background that would be sufficient to fill the largest size of the gap area, and determines how much and which portion of the additional background should be used in filling the gap area. Optionally, when the gap area is increased in size as the user continues to pull the content boundary further inside the edge of the window, the device does not need to create the additional background again, but instead simply adjusts the portion of the additional background to be displayed in the gap area based on the changed size of the gap area. Optionally, when the gap area is decreased in size from the scroll input in different directions or from the return movement (upon detection of the release of the contact or, optionally, end of the input), the device adjusts the portion of the additional background so that a smaller portion of the additional background is selected for display in the shrinking gap area.

[0276] In some embodiments, when the device is triggered to create the additional background, the device creates the additional background just for the current size of the gap area. As the gap area is increased in size from the continued scroll input from the user, the device creates further additional back-

US 2016/0202865 A1

Jul. 14, 2016

25

ground to be displayed in the enlarged gap area. Optionally, as the gap area is decreased in size from the scroll input in different directions or from the return movement (upon detection of the release of the contact or, optionally, end of the input), the device removes (e.g., erases from the memory) the unnecessary additional background in view of the shrinking gap area.

[0277] In some embodiments, the display of the additional background occupies the entire gap area 601-G, as shown in FIG. 6D. Optionally, the display of the additional background occupies a partial area of the gap area 601-G. For example, the device determines how much of the gap area 601-G is to be occupied with the display of the additional background based on various factors such as a location, type, and/or size of various object(s) within the electronic document, particularly the objects that are near the content boundary that has been pulled inside the edge of the window and therefore defines the gap area.

[0278] In some embodiments, the additional background that matches the original background 612 of the electronic document causes the visual illusion of the content boundary 601-a of the electronic document being affixed to the edge of the window even though the content boundary 601-a is actually pulled inside the edge of the window. Optionally, the content boundary 601-a is displayed with a visual effect so as to notify the users of its actual location (e.g., a dotted line as shown in FIG. 6D, a flashing line, or any other visual marker).

[0279] Referring back to FIG. 6E, the device detects a lift-off of the contact at 620-c (optionally, the end of the scroll input, a liftoff of one or more contacts that performed the scroll input, ceasing to detect one or more user gestures that performed the scroll input, etc.), the device starts rolling back the content boundary 601-a toward window edge 606-a until the content boundary 601-a reaches window edge 606-a (FIG. 6F) which optionally occurs without further user intervention (e.g., the content bounces back automatically). As the content boundary 601-a is moved closer to the edge of the window as it is being translated in the upward direction, the size of the gap area 601-G is reduced and, therefore, less amount of additional background is displayed. When the content boundary 601-a reaches window edge 606-a, the gap 601-G is completely removed, and the display of the additional background is also removed (FIG. 6F).

[0280] The various features described above with reference to FIGS. 6A-6F are optional, and any one or more of these features can be removed, modified, or combined with any other features described herein with reference to other figures (e.g., FIGS. 5A-5T and FIGS. 6G-6L), as will be apparent to those skilled in the art. For brevity, such modifications and permutations are not repeated but are deemed within the scope of the present disclosure.

[0281] FIGS. 6G-6L illustrate an example of displaying an additional background in a gap between a content boundary of an electronic document and an edge of a window. In FIG. 6G, the electronic document 607 is displayed in window 606. The electronic document includes objects 614, 612 of the third-type, object 610 of the first type, top content boundary 607-a (not shown in FIG. 6G but shown in FIG. 6H) and background 670 (e.g., a pattern of solid horizontal lines). The electronic document is displayed in window 606 with background 670, and the menu bar 680 is displayed above the top edge of the window 606-a. The menu bar 680 has a first set of display characteristic (e.g., not transparent to the electronic document or the additional background, if exists) before

detection of the input that corresponds to a request to translate the electronic document 607 displayed in window 606. The first set of display characteristic of the menu bar 680 optionally includes a color, a transparency, a size, a pattern, a resolution, shading, a gradient, etc.

[0282] The device then detects a finger contact at 640 followed by continuous movement of the finger in direction 642, without lifting the finger, which is recognized as an input that corresponds to a request to translate the electronic document 607 in a first direction (the downward direction). Upon detecting this input (and at substantially the same time as when respective portions of the electronic document 607 start being translated in the downward direction in accordance with the finger movement), the menu bar 680 changes its display characteristic to have a second set of display characteristic that are different from the first set. For example, as shown in FIG. 6H, the menu bar 680 becomes at least partially transparent to the electronic document 607 but not transparent to the additional background (as shown in FIG. 6H). For example, in FIG. 6H, the menu bar 680 becomes at least partially transparent to the portion of the electronic document 607 that is directly underneath the menu bar 680, including object 514 and background 670. The menu bar 680 is not transparent to the additional background (e.g., in some examples, the additional background is not even created in FIG. 6H since the content boundary 607-a has not been pulled inside window edge 606-a).

[0283] In FIG. 6H, the portion of the object 514 that is directly under the menu bar 680 is visible through the menu bar 680 from underneath, and the portion of the background 670 that is directly under the menu bar 680 is also visible through the menu bar 680 from underneath. Optionally, the menu bar 680 has a low or no transparency (e.g., less than 10% transparency) before the detection of the input that corresponds to a request to translate the electronic document 607. And, the menu bar 680 has an increased transparency (e.g., more than 15%) after the detection of the input that corresponds to a request to translate the electronic document 607 and as the respective portions of the electronic document 607 start being translated according to the detected input.

[0284] In FIG. 6I, the finger movement continues to 640-b, and the respective portions of the electronic document 607 (including the content boundary 607-a and background 670) and objects 612 and 614 of the third type, are translated in accordance with the finger movement from 640-a to 640-b, so that the content boundary 607-a reaches window edge 606-a. As the upper edge of the electronic document 607, the content boundary 607-a, passes the upper end of the menu bar 680, there is nothing to be seen through the menu bar 680 above the content boundary 607-a. However, in some embodiments, the menu bar 680 adjusts the visual appearance of at least the part of the menu bar 680 that has been passed by the content boundary 607-a (and thus is now above the content boundary 607-a), so that the adjusted visual appearance of the menu bar 680 is continuous with the background 670 of the electronic document 607. Optionally, the adjusted visual appearance of the menu bar 680 creates a visual illusion that the background 670 is attached to the upper end of the menu bar 680, and the background 670 continues to be expanded in accordance with the finger movement and seen through the menu bar 680.

[0285] In FIG. 6I, the content boundary 607-a has passed the menu bar 680 and is on the lower end of the menu bar 680, which coincides with window edge 606-a. So, the entire menu bar 680 is displayed with an adjusted visual appearance

US 2016/0202865 A1

Jul. 14, 2016

26

so that it appears to be continuous with the background 670. As explained, the menu bar 680 adjusts the visual appearance to cause a visual illusion that an extension of the original background 670 is seen through the menu bar 680.

[0286] In some embodiments, the adjustment of the visual appearance of the menu bar 680 for the part that has been passed by the content boundary 607-a is performed based on one or more attributes of the original background 670 of the electronic document 607. Optionally, the attributes of the original background 670 that are considered in adjusting the visual appearance of the menu bar 680 are the same as those that are considered in creating the additional background. The creation of the additional background is explained in detail with reference to FIGS. 6A-6F and will not be repeated here, for brevity.

[0287] Optionally, the device adjusts the visual appearance of the menu bar so that the changed appearance of the menu bar 680, including the pattern extended and/or extrapolated from the original background 670, is displayed with less clarity than the original background (so that it feels like the created pattern shown in the menu bar 680 is a pattern put underneath the menu bar 680 and is seen through the menu bar). Optionally, the adjusted visual appearance of the menu bar 680 creates the visual illusion that the edge of the electronic document 607 (content boundary 607-a) is attached to the upper edge of the menu bar 680 even though the actual position of the content boundary 607-a is on the lower edge of the menu bar 680, which is also the top edge of the window 606-a, in FIG. 6L.

[0288] In FIG. 6J, the user continues to move the finger from 640-b to 640-c, and in accordance with this movement, the content boundary 607-a is pulled inside window edge 606-a. As the content boundary 607-a is pulled inside window edge 606-a, gap 607-G is created. The gap 607-G is displayed at least partially with an additional background that is created by matching all or part of the attributes of the original background 670 of the electronic document 607 (e.g., color, pattern, resolution, orientation, etc.). The details of the additional background creation are explained with reference to FIGS. 6A-6F and will not be repeated, for brevity.

[0289] In some embodiments, as shown in FIG. 6J, while the additional background is displayed in the gap area 607-G, the menu bar 680 maintains the display of the adjusted visual appearance from FIG. 6I so that it continues to provide the visual effect that there is a material continuous with the additional background displayed in the gap 607-G, which is being seen through the menu bar 680 from underneath.

[0290] In FIG. 6K, the device detects an end of the input (a lift-off of the contact at 640-c), and in response to the detection of the end of the input, the device translate the respective portions of the electronic document 607 in direction 644 that is opposite the direction 642 in which the electronic document was previously translated in accordance with the finger movement.

[0291] In FIG. 6L, the translation of the respective portions of the electronic document 607 in the upward direction is continued until the content boundary 607-a reaches window edge 606-a. When the content boundary 607-a reaches window edge 606-a and the respective portions of the electronic document 607 are no longer translated, the menu bar 680 is displayed without the adjusted visual appearance (e.g., the visual appearance that has contributed to creating the visual effect that a material continuous from the background 670 is seen through the menu bar 680 from underneath is removed)

as shown in FIG. 6L. Further, optionally, when the content boundary 607-a reaches window edge 606-a and the respective portions of the electronic document 607 are no longer translated, the menu bar 680 reverts its display characteristics to the first set of display characteristics, which is the characteristic had by the menu bar 680 before the detection of the input that corresponds to the request to translate the electronic document in the first direction (e.g., the increased transparency of the menu bar 680 reverts back to the low/no transparency level).

[0292] In some embodiments, instead of adjusting the visual appearance of the menu bar 680, the menu bar 680 is made transparent to the additional background, and the device creates the additional background based on the original background of the electronic document for display not only in the gap area (e.g., 607-G) between the pulled content boundary and the edge of the window but also in the area underneath the menu bar 680.

[0293] It should be understood that the techniques described herein for creating the additional background and enabling the display of the additional background in the gap area between the content boundary and the edge of the window are provided only as exemplary, and various modifications can be made to tailor any specific design needs as will be apparent to those skilled in the art. All of such modifications are deemed within the scope of the present disclosure.

[0294] Further, the various features described above with reference to FIGS. 6G-6L are optional, and any one or more of these features can be removed, modified, or combined with any other features described herein with reference to other figures (e.g., FIGS. 5A-5T and FIGS. 6A-6F), as will be apparent to those skilled in the art. For brevity, such modifications and permutations are not repeated but are deemed within the scope of the present disclosure.

[0295] FIGS. 7A-7B are a flow diagram illustrating process 700 for coordinating movement behaviors of an electronic document and various objects contained therein in response to an input that corresponds to a request to translate the electronic document. Optionally, process 700 is performed at an electronic device with a display and a touch-sensitive surface, like device 100 (FIG. 1), device 300 (FIG. 3), and/or device 460 (FIG. 4C). At block 702, the device displays an electronic document on a display (e.g., electronic document 505, 535 and 555 as shown in FIGS. 5A-5T). Optionally, the electronic document comprises a first object (e.g., object 510 of a first type in electronic document 505) and a content boundary (e.g., top content boundary 505-a of electronic document 505, top content boundary 535-a of electronic document 535, top content boundary 555-a of electronic document 555, right-side content boundary 505-c of electronic document 505). Optionally, the electronic document is displayed in a window (e.g., 504 in FIG. 5A) that optionally comprises a URL bar (e.g., 507 in FIG. 5A), a menu bar (e.g., 508 in FIG. 5A) and a content window (e.g., 506 in FIG. 5A) for displaying the actual content of the electronic document.

[0296] At block 704, while the device displays the electronic document in the window displayed on the display, the device detects an input that corresponds to a request to translate the electronic document in a first direction. Optionally, the input includes an initial finger contact with the touch-sensitive display followed by continuous movement of the contact in the first direction (e.g., contact 520-a followed by movement 522 in FIG. 5A, contact 540-a followed by movement 542 in FIG. 5G, contact 560 followed by movement 562



US 2016/0202865 A1

Jul. 14, 2016

27

in FIG. 5L, contact **580** followed by movement **582** in FIG. 5Q). Optionally, the input includes a stylus input, a mouse input, a hand-motion input, a face-motion input, an eye-movement input, and/or other bodily part motion input that requests the device to translate the electronic document in the first direction. Optionally, the first direction in which the translation of the electronic document is requested is the same direction in which the finger is moved (e.g., directions **522**, **542**, **562**, and **582**). Optionally, the first direction in which the translation of the electronic document is requested is not the same direction in which the finger is moved or any other input is applied (e.g., a user swipes to the left which is interpreted as a request to translate the electronic document to the right, etc.).

[0297] At block **706**, in response to detecting the input that corresponds to a request to translate the electronic document in the first direction, the device translates the electronic document in the first direction in accordance with the detected input without translating the first object (e.g., in FIGS. 5A-5E, as the electronic document is translated in the downward direction in accordance with the contact movement **520-a** to **520-d**, the object **510** of the first type is not translated and remains stationary relative to the edges of the window **506**). The user continues to provide the input to further translate the electronic document, so that the first object (e.g., object **510**) is outside the content boundary (e.g., **505-a**) of the electronic document on the display (e.g., as the content boundary **505-a** is pulled inside window edge **506-a**, the object **510** is outside the content boundary as shown in FIG. 5D).

[0298] Optionally, the device translates the respective portion of the electronic document in the first direction in accordance with the input by translating the respective portion of the electronic document in the first direction in a linear relationship with the input until the content boundary of the electronic document reaches the edge of the window (e.g., until the content boundary **505-a** reaches window edge **506-a** in FIG. 5C) and then translates the respective portion of the electronic document in the first direction in a non-linear relationship with the input after the content boundary has reached the edge of the window and as it is pulled inside the edge of the window (e.g., FIG. 5D).

[0299] Optionally, the device translates the respective portion of the electronic document in the first direction in a linear relationship with the detected input by translating by an amount that is proportional to the distance moved by the finger on the touch-sensitive display (e.g., in FIG. 5B, the distance moved by the finger from **520-a** to **520-b** is proportional to the amount translated by the respective portion of the electronic document **505** and the amount translated by the third-type objects **514** and **512**; and in FIG. 5C, the distance moved by the finger from **520-b** to **520-c** is proportional to the amount translated by the respective portion of the electronic document **505** and the amount translated by the third-type objects **514** and **512**).

[0300] Optionally, the device translates the respective portion of the electronic document in the first direction in a non-linear relationship with the detected scroll input by translating by an amount that has a non-linear relationship with the distance moved by the finger on the touch-sensitive display (e.g., in FIG. 5D, the distance moved by the finger from **520-c** to **520-d** has a non-linear relationship with the amount trans-

lated by the respective portion of the electronic document **505** and the amount translated by the third-type objects **514** and **512**).

[0301] Optionally, the first object (e.g., object **510** in FIGS. 5A-5F) is fixed relative to the edge(s) of the window (e.g., **506-a**) and remains fixed while the electronic document is translated (e.g., FIGS. 5A-5F). The device translates the respective portion of the electronic document without translating the first object so that a portion of the electronic document is translated under the first object (e.g., in FIG. 5A-5F, as the respective portion of the electronic background **505** is translated up and down, a portion of the electronic document that is directly underneath the first object is translated as if passing under the first object). The first object also remains stationary as the respective portion of the electronic document is translated in the second direction after the end of the input is detected (e.g., in FIGS. 5E and 5F, the first-type object **510** remains stationary as the respective portion of the electronic document is translated in the upward direction after the lift-off of the contact is detected).

[0302] Optionally, as shown in FIG. 7B, the electronic document further comprises a second object (e.g., object **530** of a second type in electronic document **535** in FIGS. 5G-5K). When the device translates the respective portion of the electronic document (e.g., **535**) in the first direction in accordance with the detected input (e.g., contact movement from **540-a** to **540-b** in FIG. 5H), the second object remains stationary until the content boundary reaches the edge of the window (e.g., in FIG. 5H, the second-type object **530** remains stationary until the content boundary **535-a** reaches window edge **506-a**). However, when the respective portion of the electronic document is translated in a non-linear relationship as the content boundary of the electronic document is pulled inside the edge of the window, the second object is translated with the respective portion of the electronic document in the non-linear relationship with the input (e.g., in FIG. 5I, the second-type object **530** is translated down with the respective portion of the electronic document in a non-linear relationship with the contact movement from **540-b** to **540-c**). The second object is also translated with the respective portion of the electronic document during the translation in the second direction after the end of the input is detected (e.g., in FIGS. 5J and 5K, the second-type object **530** is translated in the upward direction along with the respective portion of the electronic document after the lift-off of the contact is detected).

[0303] Optionally, the electronic document further comprises a third object (e.g., objects **512** and **514** of a third type in electronic documents **505**, **535** and **555** in FIGS. 5A-5T). When the device translates the respective portion of the electronic document in the first direction in accordance with the detected input, the third object (e.g., objects **512** and **514**) is translated with the respective portion of the electronic document in the first direction in a linear relationship with the input until the content boundary of the electronic document reaches the edge of the window. The third object also is translated with the respective portion of the electronic document in the first direction in a non-linear relationship with the input after the content boundary has reached the edge of the window and as the content boundary is pulled inside the edge of the window. Optionally, the third object (e.g., objects **512** and **514** of the third type) is fixed relative to the edges of the electronic document (e.g., content boundaries of the electronic documents) so that the third object is translated along with the movement of the respective portion of the electronic

US 2016/0202865 A1

Jul. 14, 2016

28

document (either during the translation from the user input and translation after the end of the input).

[0304] Optionally, the electronic document further comprises a fourth object (e.g., object **550** of a fourth type in electronic document **555** in FIGS. **5L-5P**). When the device translates the respective portion of the electronic document (e.g., **555**) in the first direction in accordance with the detected input (e.g., contact movement from **560-a** to **560-b** in FIG. **5M**), the fourth object (e.g., object **550**) is translated with the respective portion of the electronic document in a linear relationship with the input until the content boundary of the electronic document (e.g., **555-a**) reaches the edge of the window (e.g., **506-a**). When the respective portion of the electronic document (e.g., **555**) is translated in a non-linear relationship with the input (e.g., contact movement from **560-b** to **560-c** in FIG. **5N**) as the content boundary of the electronic document is pulled inside the edge of the window, the fourth object (e.g., **550**) is not translated and remains stationary relative to the edges of the window (e.g., **506-a**). The fourth object remains stationary even if that means the fourth object (e.g., **550**) is pulled out of the content boundary (e.g., **555-a** in FIG. **5N**). The fourth object remains stationary as the respective portion of the electronic document is translated in the second direction after the end of the input is detected (e.g., in FIGS. **5O** and **5P**, the fourth-type object **550** remains stationary while the electronic document **555** is subject to the restoration behavior in the upward direction after the lift-off of the contact is detected).

[0305] At block **708**, the device detects a liftoff of the finger contact that provided the scroll input (FIGS. **5E**, **5J**, **5O** and **5S**). At block **710**, in response to detecting the release of the finger contact (or, optionally, the end of the scroll input, a liftoff of one or more contacts that performed the scroll input, ceasing to detect one or more user gestures that performed the scroll input, etc.), the device translates the respective portion of the electronic document in a second direction different from the first direction without moving the first object (e.g., object **510** of the first type in FIGS. **5E** and **5S**). Optionally, the electronic document is moved in the second direction until the content boundary (e.g., **505-a** in FIG. **5E**, **535-a** in FIG. **5J**, **555-a** in FIGS. **5O** and **505-c** in FIG. **5S**) reaches the respective edge of the window (e.g., **506-a** in FIGS. **5E**, **5J** and **5O** and **506-c** in FIG. **5S**). For example, in FIGS. **5E** and **5S**, the electronic document is translated in the second direction so that the first object (e.g., object **510**) is within the content boundary (e.g., **505-a** in FIG. **5E** and **505-c** in FIG. **5S**). Optionally, the second direction (e.g., **524**, **544**, **564**, **584** FIGS. **5E**, **5J**, **5O** and **5S**) is opposite the first direction (e.g., **522**, **542**, **562**, **584** FIGS. **5E**, **5J**, **5O** and **5S**). Optionally, the electronic document is translated in the second direction at a speed faster than a speed of the translation of the electronic document in the first direction in accordance with the scroll input.

[0306] It should be understood that the particular order in which the operations in FIGS. **7A-7B** have been described is merely exemplary and is not intended to indicate that the described order is the only order in which the operations could be performed. One of ordinary skill in the art would recognize various ways to reorder the operations described herein. Additionally, it should be noted that details of other processes described herein with respect to other methods described herein (e.g., method **800**) are also applicable in an analogous manner to method **700** described above with respect to FIGS. **7A-7B**. For example, the inputs, translation

behaviors of the electronic document, translation behaviors of various objects of different types contained in the electronic document (e.g., objects of the first type, second type, third type and/or fourth type), visual effects and behavior control of the electronic document relative to those of the objects, described above with reference to method **700** optionally have one or more of the characteristics of the inputs, translation behaviors of the electronic document, translation behaviors of various objects of different types contained in the electronic document (e.g., objects of the first type, second type, third type and/or fourth type), visual effects and behavior control of the electronic document relative to those of the objects that are described herein with reference to other methods described herein (e.g., method **800**). For brevity, these details are not repeated here.

[0307] The operations in the information processing methods described above may be implemented by running one or more functional modules in information processing apparatus such as general purpose processors or application specific chips. These modules, combinations of these modules, and/or their combination with general hardware (e.g., as described above with respect to FIGS. **1A**, **1B** and **3**) are all included within the scope of protection of the invention.

[0308] The operations described above with reference to FIGS. **7A-7B** are, optionally, implemented by components depicted in FIGS. **1A-1B** and **9**. For example, detection operations **704** and **708**, displaying operation **702**, and translating operations **706** and **710** are, optionally implemented by event sorter **170**, event recognizer **180**, and event handler **190**. Event monitor **171** in event sorter **170** detects a contact on touch-sensitive display **112**, and event dispatcher module **174** delivers the event information to application **136-1**. A respective event recognizer **180** of application **136-1** compares the event information to respective event definitions **186**, and determines whether a first contact at a first location on the touch-sensitive surface corresponds to a predefined event or sub-event, such as selection of an object on a user interface. When a respective predefined event or sub-event is detected, event recognizer **180** activates an event handler **190** associated with the detection of the event or sub-event. Event handler **190** optionally utilizes or calls data updater **176** or object updater **177** to update the application internal state **192**. In some embodiments, event handler **190** accesses a respective GUI updater **178** to update what is displayed by the application. Similarly, it would be clear to a person having ordinary skill in the art how other processes can be implemented based on the components depicted in FIGS. **1A-1B** and **9**.

[0309] FIGS. **8A-8C** are a flow diagram illustrating process **800** for coordinating the movement behavior of the electronic document and various objects contained therein in response to an input that corresponds to a request to translate the electronic document. Optionally, process **800** is performed at an electronic device with a display and a touch-sensitive surface, like device **100** (FIG. **1**), device **300** (FIG. **3**), and/or device **460** (FIG. **4C**). At block **802**, the device displays, in a window of a display, an electronic document comprising a background and a content boundary. For example, in FIG. **6A**, the electronic document **601** that comprises background **612** and content boundary **601-a** (shown in FIG. **6B**) is displayed in a window (e.g., window **604** including a URL bar, a menu bar, and content window **606**).

[0310] At block **804**, while the device displays the electronic document in the window, the device detects an input corresponding to a request to translate the electronic docu-



US 2016/0202865 A1

Jul. 14, 2016

29

ment in a first direction (e.g., in FIG. 6A, the initial finger contact with the touch-sensitive display at **620** followed by continuous movement of the contact **622**, and in FIG. 6G, the initial finger contact with the touch-sensitive display at **640** followed by continuous movement of the contact **642**). Optionally, the input includes a stylus input, a mouse input, a hand-motion input, a face-motion input, an eye-movement input, and/or other bodily part motion input that requests the device to scroll the electronic document in the first direction. Optionally, the first direction in which the scroll of the electronic document is requested is the same direction in which the finger is moved (e.g., directions **622** and **642**). Optionally, the first direction in which the scroll of the electronic document is requested is not the same direction in which the finger is moved or any other scroll input is applied (e.g., a user swipes to the left which is interpreted as a request to scroll the electronic document to the right, etc.).

[0311] At block **806**, in response to detecting the input that corresponds to a request to translate the electronic document in the first direction, the device translates a respective portion of the electronic document in the first direction in accordance with the detected input without moving the first object, so that the content boundary is pulled inside the edge of the window. For example, in FIG. 6B, the respective portion of the electronic document **601** (including the background **612** and content boundary **601-a**) is translated in accordance with the finger movement from **620-a** to **620-b** so that the content boundary **601-a** reaches the edge of the content window **606-a**, and continues to be translated in accordance with the further movement of the finger from **620-b** to **620-c** so that the content boundary **601-a** is pulled inside window edge **606-a**, as shown in FIG. 6C.

[0312] In conjunction with translating the respective portion of the electronic document so that the content boundary is pulled inside the edge of the window, the device displays an additional background in at least a portion of a gap area (e.g., **601-G** in FIG. 6D and **607-G** in FIG. 6J) between the pulled content boundary and the edge of the window. Optionally, the one or more attributes of the additional background match the corresponding one or more attributes of the background of the electronic document (e.g., in FIG. 6D the pattern and color of the additional background displayed in **601-G** match the pattern and color of the original background **612** of the electronic document **601**, and in FIG. 6J, the pattern and color of the additional background displayed in **601-G** match the pattern and color of the original background **670** of the electronic document **607**). Optionally, the one or more attributes of the background that are matched in the additional background include at least one of a pattern, an orientation, an image, a resolution, a gradient, a shading, a transparency, a size, etc. Optionally, the additional background is generated based on a replication and/or extrapolation of the one or more attributes of the original background.

[0313] Optionally, the device generates the additional background based on the one or more attributes of the original background of the electronic document prior to displaying the additional background in at least the portion of the area (e.g., **601-G** in FIG. 6D and **607-G** in FIG. 6J) between the content boundary and the edge of the window. Optionally, the device generates the additional background prior to detecting the scroll input that would cause the content boundary to be pulled inside the edge of the window (before the gap area **601-G** in FIG. 6D and **607-G** in FIG. 6J is created), or after detecting such scroll input.

[0314] Optionally, as shown in FIG. 8B, the device translates the respective portion of the electronic document in the first direction in accordance with the input by translating in a linear relationship with the detected input (e.g., in FIG. 6B the translation had by the respective portion of the electronic document **601** has a linear relationship with the contact movement from **620-a** to **620-b**; and in FIG. 6I the translation had by the respective portion of the electronic document **607** has a linear relationship with contact movement from **640-a** to **640-b**) until the content boundary (e.g., **601-a**, **607-a**) reaches the edge of the window (e.g., **606-a**). Subsequently, the device translates the respective portion of the electronic document in the first direction in a non-linear relationship with the detected input (e.g., contact movement from **620-b** to **620-c** in FIGS. 6C and 6D, and contact movement from **640-b** to **640-c** in FIG. 6J) as the content boundary is pulled inside the edge of the window (e.g., **601-a** in FIGS. 6C and 6D, and **607-a** in FIG. 6J).

[0315] Optionally, while the respective portion of the electronic document is translated in the first direction in the non-linear relationship with the detected input, the additional background is displayed in all or at least a portion of the area between the content boundary and the edge of the window (e.g., gap area **601-G** in FIG. 6D and gap area **607-G** in FIG. 6J). The size of the portion of the area where the additional background is displayed increases as the content boundary of the electronic document continues to be pulled further inside the edge of the window.

[0316] Optionally, the electronic document comprises a first object (e.g., object **510** in FIGS. 6A-6L) that remains stationary while the respective portion of the electronic document is translated in the first direction in accordance with the detected scroll input or translated in the second direction after the release of the contact that provided the scroll input. Optionally, while the respective portion of the electronic document is translated without translating the first object, a portion of the electronic document is passed under the first object, and sometimes, the content boundary is translated under the first object so that the first object is pulled outside the content boundary (e.g., **610** in FIGS. 6D and 6J). Optionally, the portion of the electronic document that is passed under the first object is at least partially visible through the first object from underneath.

[0317] Continuing to FIG. 8C, optionally, a respective portion of the window (e.g., menu bar **680** in FIGS. 6G-6L) changes a visual appearance in response to the input that corresponds to a request to translate the electronic document **607**. For example, the respective portion of the window (e.g., menu bar **680** in FIGS. 6G-6L) is not transparent to either the electronic background or the additional background before the detection of the input (e.g., in FIG. 6G, the menu bar **680** is displayed as opaque to the electronic document **607**). After the detection of the input that corresponds to a request to translate the electronic document and as the respective portion of the electronic document starts being translated as requested, the respective portion of the window (e.g., menu bar **680** in FIGS. 6G-6L) becomes transparent to the electronic document. Optionally, the respective portion of the window is not transparent to the additional background.

[0318] While the content boundary of the electronic document (e.g., an edge of the electronic document **607-a** in FIGS. 6I and 6J) has been translated under the respective portion of the window (e.g., menu bar **680** in FIGS. 6G-6L) in accordance with the input (e.g., contact movement from **640-a** to

US 2016/0202865 A1

Jul. 14, 2016

30

**640-b** in FIG. 6I and to **640-c** in FIG. 6J), the respective portion of the window is displayed with an adjusted visual appearance based on an appearance of the electronic document (e.g., **607**) including the background (e.g., **670**). Optionally, the adjusted visual appearance of the respective portion of the window (e.g., menu bar **680** in FIGS. 6G-6L) creates a visual illusion that there is an additional background underneath the respective portion of the window, which is at least partially seen through the respective portion of the window from under (e.g., the adjusted appearance of the menu bar **680** in FIGS. 6I and 6J). Optionally, the actual additional background is displayed only in the gap area (e.g., **607-G** in FIG. 6J) and not in the area underneath the menu bar, and the continuity between the menu bar **680** and the additional background is achieved by the adjusted visual appearance of the menu bar. The adjusted appearance of the menu bar **680** creates an illusion that there is an additional background that extends to the area underneath the menu bar **680** from the actual additional background in the gap area **607-G**.

[0319] Optionally, while the content boundary of the electronic document (e.g., **607-a**) that was adjacent the actual additional background (e.g., in **607-G** in FIG. 6K) has become adjacent to the respective portion of the window (e.g., **680**) such that the electronic document is not scrolled under the respective portion of the window (e.g., in FIG. 6L, upon the completion of the restoration behavior, the content boundary **607-a** that was adjacent to the gap area **607-G** is now adjacent to the menu bar **680**, and the restoring translation stops when the content boundary **607-a** reaches window edge **606-a**, therefore, no part of the electronic document is translated under the menu bar **680**), the device displays the respective portion of the window (e.g., **680**) without adjustment for the appearance of the additional background (e.g., menu bar **680** in FIG. 6L). For example, the content boundary **607-a** that was previously adjacent the gap **607-G** in FIG. 6K is translated in the upward direction (e.g., **644**) after the detection of the end of the input so that the content boundary **607-a** is now adjacent to the menu bar **680** upon the completion of the restoration behavior, as shown in FIG. 6L (e.g., content boundary **6087-a** is adjacent to the menu bar **680**, and the gap area **607-G** is removed). Then, the menu bar **680** is displayed without the pattern that was previously created to adjust for the background **670** and/or additional background in **607-G**. Optionally, the respective portion of the electronic document (e.g., menu bar **680**) has a first value of transparency prior to the detection of the input that corresponds to a request to translate the electronic document (e.g., FIG. 6G), and has a second value of transparency higher than the first value after the detection of the input (e.g., FIGS. 6H-6K). Then, after the restoration behavior is complete after the detection of the end of the input, the respective portion of the window (e.g., **680**) returns to have the first value of transparency (e.g., FIG. 6L).

[0320] At block **808**, the device detects an end of the input (e.g., a liftoff of the contact from the display). At block **810**, in response to detecting the end of the input, the device translates the respective portion of the electronic document in the second direction opposite the first direction until the content boundary of the electronic document reaches the edge of the window. For example, in FIG. 6E, upon detecting the liftoff of the contact from the display at **620-c**, the respective portion of the electronic document **601** is translated in the second direction **624** opposite the first direction **622** until the content boundary **601-a** reaches window edge **606-a**. This movement of the respective portion of the electronic docu-

ment **601** in the second direction **624** causes a reduction in size of the gap area in which the additional background is displayed (e.g., the size of the gap **601-G** reduces in accordance with the movement of the electronic document in direction **624**). The translation of the respective portion of the electronic document in the second direction continues until the portion of the area (e.g., **601-G**) is completely removed, as shown in FIG. 6F. Optionally, the respective portion of the electronic document is translated in the second direction upon the detection of the end of the input at a speed faster than a speed of the translation of the respective portion of the electronic document in the first direction in accordance with the input.

[0321] It should be understood that the particular order in which the operations in FIGS. 8A-8C have been described is merely exemplary and is not intended to indicate that the described order is the only order in which the operations could be performed. One of ordinary skill in the art would recognize various ways to reorder the operations described herein. Additionally, it should be noted that details of other processes described herein with respect to other methods described herein (e.g., method **700**) are also applicable in an analogous manner to method **800** described above with respect to FIGS. 8A-8C. For example, the inputs, translation behaviors of the electronic document, translation behaviors of various objects of different types contained in the electronic document (e.g., objects of the first type, second type, third type and/or fourth type), visual effects and behavior control of the electronic document relative to those of the objects, described above with reference to method **800** optionally have one or more of the characteristics of the inputs, translation behaviors of the electronic document, translation behaviors of various objects of different types contained in the electronic document (e.g., objects of the first type, second type, third type and/or fourth type), visual effects and behavior control of the electronic document relative to those of the objects described herein with reference to other methods described herein (e.g., method **700**). For brevity, these details are not repeated here.

[0322] The operations in the information processing methods described above may be implemented by running one or more functional modules in information processing apparatus such as general purpose processors or application specific chips. These modules, combinations of these modules, and/or their combination with general hardware (e.g., as described above with respect to FIGS. 1A, 1B and 3) are all included within the scope of protection of the invention.

[0323] The operations described above with reference to FIGS. 8A-8C are, optionally, implemented by components depicted in FIGS. 1A-1B and 10. For example, detection operations **804** and **808**, displaying operation **802**, and translating operations **806** and **810** are, optionally implemented by event sorter **170**, event recognizer **180**, and event handler **190**. Event monitor **171** in event sorter **170** detects a contact on touch-sensitive display **112**, and event dispatcher module **174** delivers the event information to application **136-1**. A respective event recognizer **180** of application **136-1** compares the event information to respective event definitions **186**, and determines whether a first contact at a first location on the touch-sensitive surface corresponds to a predefined event or sub-event, such as selection of an object on a user interface. When a respective predefined event or sub-event is detected, event recognizer **180** activates an event handler **190** associated with the detection of the event or sub-event. Event han-

US 2016/0202865 A1

Jul. 14, 2016

31

handler 190 optionally utilizes or calls data updater 176 or object updater 177 to update the application internal state 192. In some embodiments, event handler 190 accesses a respective GUI updater 178 to update what is displayed by the application. Similarly, it would be clear to a person having ordinary skill in the art how other processes can be implemented based on the components depicted in FIGS. 1A-1B and 10.

[0324] FIG. 9 shows exemplary functional blocks of an electronic device 900 that, in some examples, perform the features described above. The functional blocks of the device are, optionally, implemented by hardware, software, or a combination of hardware and software to carry out the principles of the various described embodiments. It is understood by persons of skill in the art that the functional blocks described in FIG. 9 are, optionally, combined or separated into sub-blocks to implement the principles of the various described embodiments. Therefore, the description herein optionally supports any possible combination or separation or further definition of the functional blocks described herein.

[0325] As shown in FIG. 9, an electronic device 900 optionally includes a display unit 902 configured to display an electronic document in a window, a communication unit 904 configured to communicate with an external device (e.g., to receive the electronic document, and/or receive any further information about the background of the electronic document, etc.); one or more sensor units 906 configured to detect an input that corresponds to a request to translate the electronic document; and a processing unit 908 coupled to display unit 902, communication unit 904, and sensor units 906. Optionally, processing unit 908 is configured to display, in a window on display unit 902, an electronic document that comprises a content boundary, one or more objects of different types (e.g., first-type, second-type, third-type and fourth-type), and a background, using display enabling unit 910.

[0326] Optionally, processing unit 908 is configured to recognize that the detected input corresponds to a request to translate the electronic document in a first direction, using request detecting unit 912. Optionally, processing unit 908 is configured to translate a respective portion of the electronic document as requested in accordance with the detected input, using translating unit 914. Optionally, processing unit 908 is configured to generate an additional background to be displayed in all or part of the gap area between the content boundary and the edge of the window as the input causes the content boundary to be pulled inside the edge of the window (e.g., FIGS. 5D, 5I, 5N, 5R, 6D, 6J).

[0327] Optionally, the device displays, on display unit 902, an electronic document on a display, using display enabling unit 910. Optionally, the electronic document (e.g., electronic document 505, 535 and 555 in FIGS. 5A-5T) comprises a first object (e.g., object 510 of a first type in electronic document 505) and a content boundary (e.g., top content boundary 505-a of electronic document 505, top content boundary 535-a of electronic document 535, top content boundary 555-a of electronic document 555, right-side content boundary 505-c of electronic document 505). Optionally, the electronic document is displayed in a window (e.g., 504 in FIG. 5A) that comprises a URL bar (e.g., 507 in FIG. 5A), a menu bar (e.g., 508 in FIG. 5A) and/or a content window (e.g., 506 in FIG. 5A) for displaying the content of the electronic document.

[0328] Optionally, while the device displays the electronic document in a window displayed on the display, the device detects an input provided by a user, using sensor units 906

(e.g., contact 520-a followed by movement 522 in FIG. 5A, contact 540-a followed by movement 542 in FIG. 5G, contact 560 followed by movement 562 in FIG. 5L, contact 580 followed by movement 582 in FIG. 5Q), and determines that such input corresponds to a request to translate the electronic document in a first direction, using request detecting unit 912. Optionally, the device detects using sensor units 906 an input that includes a stylus input, a mouse input, a hand-motion input, a face-motion input, an eye-movement input, and/or other bodily part motion input, and determines using request detecting unit 912 that the detected input corresponds to a request to scroll the electronic document in the first direction. Optionally, the device determines using request detecting unit 912 that the first direction in which the scroll of the electronic document is requested is the same direction in which the finger is moved (e.g., directions 522, 542, 562, and 582). Optionally, the device determines using request detecting unit 912 that the first direction in which the scroll of the electronic document is requested is not the same direction in which the finger is moved or any other scroll input is applied (e.g., a user swipes to the left which is interpreted as a request to scroll the electronic document to the right, etc.).

[0329] Optionally, in response to detecting the input that corresponds to a request to translate the electronic document in the first direction, the device translates a respective portion of the electronic document (e.g., content boundary, background of the electronic document) in the first direction in accordance with the detected input without translating the first object, using translating unit 914 (e.g., in FIGS. 5A-5E, as the electronic document is translated in the downward direction in accordance with the detected finger movement 520-a to 520-d on the display, the object 510 of the first type is not translated and remains stationary). If the input continues to be detected, the translation of the respective portion is also continued by translating unit 914, so that the first object (e.g., object 510) is outside the content boundary (e.g., 505-a) of the electronic document on the display (e.g., as the content boundary 505-a is pulled inside window edge 506-a, the object 510 is outside the content boundary as shown in FIG. 5D).

[0330] Optionally, translating unit 914 causes the device to translate the respective portion of the electronic document in the first direction in accordance with the input by translating in a linear relationship with the detected input until the content boundary of the electronic document reaches the edge of the window (e.g., the translation is in a linear relationship with the finger movement 520-a to 520-c until the content boundary 505-a reaches window edge 506-a in FIGS. 5A-5C) and translating the respective portion of the electronic document in the first direction in a non-linear relationship with the detected input after the content boundary has reached the edge of the window and as the content boundary is pulled inside the edge of the window (e.g., the translation is in a non-linear relationship with the finger movement 520-c to 520-d in FIG. 5D).

[0331] Optionally, translating unit 914 causes the device to translate the respective portion of the electronic document in the first direction in a linear relationship with the detected input by an amount that is proportional to the distance moved by the finger on the touch-sensitive display. For example, in FIG. 5B, the distance moved by the finger from 520-a to 520-b is proportional to the amount of the translations of the electronic document 505 (e.g., the amount moved by objects 514 and 512). In FIG. 5C, the distance moved by the finger



US 2016/0202865 A1

Jul. 14, 2016

32

from **520-b** to **520-c** is proportional to the amount of the translation of the electronic document **505** (e.g., the amount moved by objects **514** and **512**).

[0332] Optionally, translating unit **914** causes the device to translate the respective portion of the electronic document in the first direction in a non-linear relationship with the detected scroll input by an amount that has a non-linear relationship with the distance moved by the finger on the touch-sensitive display. For example, in FIG. **5D**, the distance moved by the finger from **520-c** to **520-d** has a non-linear relationship with the amount of the translation of the electronic documents (e.g., the amount moved by objects **514** and **512**).

[0333] Optionally, translating unit **914** causes the first object (e.g., object **510** in FIGS. **5A-5F**) to be fixed relative to the edge(s) of the window (e.g., **506-a**) and remain stationary while the respective portion of the electronic document is translated (e.g., FIGS. **5A-5F**). Optionally, translating unit **914** causes the device to translate the respective portion of the electronic document without translating the first object so that a portion of the electronic document is passed under the first object (e.g., in FIG. **5A-5F**, the electronic background **505** is translated up and down, and a portion of the electronic documents that becomes directly under the first object as the document is translated is passed under the first object). The first object remains stationary as the respective portion of the electronic document is translated in the second direction after the end of the input is detected (e.g., in FIGS. **5E** and **5F**, the first-type object **510** remains stationary as the respective portion of the electronic document is translated in the upward direction after the liftoff of the finger is detected).

[0334] Optionally, the electronic document further comprises a second object (e.g., object **530** of a second type in electronic document **535** in FIGS. **5G-5K**), and translating unit **914** causes the device to translate the respective portion of the electronic document (e.g., **535**) in the first direction in accordance with the detected scroll input (e.g., contact movement from **540-a** to **540-b** in FIG. **5H**) by maintaining the second object stationary until the content boundary reaches the edge of the window (e.g., in FIG. **5H**, the second-type object **530** remains stationary while the electronic document until the content boundary **535-a** reaches window edge **506-a**). Optionally, translating unit **914** causes the device to translate the respective portion of the electronic document in a non-linear relationship with the input as the content boundary of the electronic document is pulled inside the edge of the window by translating the second object with the electronic document in the non-linear relationship with the input (e.g., in FIG. **5I**, the second-type object **530** moves down with the electronic document in a non-linear relationship with the contact movement from **540-b** to **540-c**). The second object is translated with the respective portion of the electronic document as the respective portion of the electronic document is translated in the second direction after the end of the input is detected (e.g., in FIGS. **5J** and **5K**, the second-type object **530** is translated in the upward direction with the respective portion of the electronic document after the liftoff of the contact is detected).

[0335] Optionally, the electronic document further comprises a third object (e.g., objects **512** and **514** of a third type in electronic documents **505**, **535** and **555** in FIGS. **5A-5T**), and translating unit **914** causes the device to translate the respective portion of the electronic document in the first direction in accordance with the detected input by translating

the third object (e.g., objects **512** and **514**) with the respective portion of the electronic document in the first direction in a linear relationship with the input until the content boundary of the electronic document reaches the edge of the window. The translating unit **914** also causes the device to translate the respective portion of the electronic document in the first direction in accordance with the detected input by translating the third object with the respective portion of the electronic document in the first direction in a non-linear relationship with the input after the content boundary has reached the edge of the window and as the content boundary is pulled inside the edge of the window. For example, the third objects (e.g., objects **512** and **514** of the third type) are fixed relative to the edges of the electronic document (e.g., content boundaries of the electronic documents) so that they move along with the movement of the respective portion of the electronic document.

[0336] Optionally, the electronic document further comprises a fourth object (e.g., object **550** of a fourth type in electronic document **555** in FIGS. **5L-5P**), and translating unit **914** causes the device to translate the respective portion of the electronic document (e.g., **555**) in the first direction in accordance with the detected input (e.g., contact movement from **560-a** to **560-b** in FIG. **5M**), by translating the fourth object (e.g., object **550**) with the respective portion of the electronic document as the respective portion of the electronic document is translated in a linear relationship with the input until the content boundary of the electronic document (e.g., **555-a**) reaches the edge of the window (e.g., **506-a**). The translating unit **914** causes the device to maintain the fourth object stationary when the respective portion of the electronic document (e.g., **555**) is translated in a non-linear relationship with the input (e.g., contact movement from **560-b** to **560-c** in FIG. **5N**) as the content boundary of the electronic document is pulled inside the edge of the window. The fourth object remains stationary even if that means the fourth object (e.g., **550**) is pulled out of the content boundary (e.g., **555-a** in FIG. **5N**). The fourth object remains stationary as the respective portion of the electronic document is translated in the second direction after the end of the input is detected (e.g., in FIGS. **5O** and **5P**, the fourth-type object **550** remains stationary as the respective portion of the electronic document **555** is translated in the upward direction with objects **512** and **530** after the liftoff of the contact is detected).

[0337] Optionally, the device detects an end of the input (e.g., a lift off of the finger contact in FIGS. **5E**, **5J**, **5O** and **5S**) using sensor units **906** and recognizes that the detected state represents an end of the translation request, using request detecting unit **912**. In response to detecting the end of the input, the device translates, using the translation unit **914**, the respective portion of the electronic document in a second direction different from the first direction without translating the first object (e.g., object **510** of the first type in FIGS. **5E** and **5S**). Optionally, the translating unit **914** causes the electronic document to be translated in the second direction until the content boundary (e.g., **505-a** in FIG. **5E**, **535-a** in FIG. **5J**, **555-a** in FIGS. **5O** and **505-c** in FIG. **5S**) reaches the respective edge of the window (e.g., **506-a** in FIGS. **5E**, **5J** and **5O** and **506-c** in FIG. **5S**). In FIGS. **5E** and **5S**, the electronic document is translated in the second direction so that the first object (e.g., object **510**) is back within the content boundary (e.g., **505-a** in FIG. **5E** and **505-c** in FIG. **5S**). Optionally, the second direction (e.g., **524**, **544**, **564**, **584** FIGS. **5E**, **5J**, **5O** and **5S**) is opposite the first direction (e.g.,

US 2016/0202865 A1

Jul. 14, 2016

33

**522, 542, 562, 584** FIGS. **5E, 5J, 5O** and **5S**). Optionally, the respective portion of the electronic document is translated in the second direction at a speed faster than a speed of the translation of the respective portion of the electronic document in the first direction in accordance with the input.

[0338] It should be noted that details of other functions described herein with respect to other devices and functions blocks of the other devices described herein (e.g., device **1000** and its functional blocks) are also applicable in an analogous manner to device **900** described above with respect to FIG. **9**. For example, processing unit **908**, display enabling unit **910**, request detecting unit **912**, translating unit **914** and background adjusting unit **916**, described above with reference to device **900** optionally have one or more of the characteristics of the processing unit **1008**, display enabling unit **1010**, request detecting unit **1012**, translating unit **1014** and background adjusting unit **1016**, described herein with reference to other devices described herein (e.g., device **1000**). For brevity, these details are not repeated here.

[0339] FIG. **10** shows exemplary functional blocks of an electronic device **1000** that, in some examples, perform the features described above. The functional blocks of the device are, optionally, implemented by hardware, software, or a combination of hardware and software to carry out the principles of the various described embodiments. It is understood by persons of skill in the art that the functional blocks described in FIG. **10** are, optionally, combined or separated into sub-blocks to implement the principles of the various described embodiments. Therefore, the description herein optionally supports any possible combination or separation or further definition of the functional blocks described herein.

[0340] As shown in FIG. **10**, an electronic device **1000** optionally includes a display unit **1002** configured to display an electronic document in a window, a communication unit **1004** configured to communicate with an external device (e.g., to receive the electronic document, and/or receive any further information about the background of the electronic document, etc.); one or more sensor units **1006** configured to detect an input that corresponds to a request to translate the electronic document; and a processing unit **1008** coupled to display unit **1002**, communication unit **1004**, and sensor units **1006**. Optionally, processing unit **908** is configured to display, in a window on display unit **1002**, an electronic document that comprises a content boundary, one or more objects of different types (e.g., first-type, second-type, third-type and fourth-type), and a background, using display enabling unit **1010**.

[0341] In some embodiments, the device **1000** displays, in a window of display **1002**, an electronic document (e.g., **601** in FIG. **6A** and **607** in FIG. **6G**) comprising a background (e.g., **612** in FIG. **6A** and **670** in FIG. **6G**) and a content boundary (e.g., **601-a** in FIG. **6A** and **607-a** in FIG. **6G**), using display enabling unit **1010**.

[0342] Optionally, while the device displays the electronic document in the window (e.g., window **604** including a URL bar, a menu bar, and/or content window **606**), the device detects, using sensor units **1006**, an input provided by a user (e.g., in FIG. **6A**, the initial finger contact with the touch-sensitive display at **620** followed by continuous movement of the contact **622**, and in FIG. **6G**, the initial finger contact with the touch-sensitive display at **640** followed by continuous movement of the contact **642**), and determines, using request detecting unit **1012**, that the detected input corresponds to a request to translate the electronic document in a first direc-

tion. Optionally, the device detects, using sensor units **1006**, an input that includes a stylus input, a mouse input, a hand-motion input, a face-motion input, an eye-movement input, and/or other bodily part motion input, and determines using request detecting unit **1012** that the detected input corresponds to a request to scroll the electronic document in the first direction. Optionally, the device determines using request detecting unit **1012** that the first direction in which the scroll of the electronic document is requested is the same direction in which the finger is moved (e.g., directions **622** and **642**). Optionally, the device determines using request detecting unit **1012** that the first direction in which the scroll of the electronic document is requested is not the same direction in which the finger is moved or any other scroll input is applied (e.g., a user swipes to the left which is interpreted as a request to scroll the electronic document to the right, etc.).

[0343] Optionally, in response to detecting the input that corresponds to a request to translate the electronic document in the first direction, the device translates the electronic document in the first direction in accordance with the detected input without translating the first object, using translating unit **1014**. In accordance with the input, translating unit **1014** causes the content boundary of the electronic document to be pulled inside the edge of the window (e.g., in FIG. **6B**, the electronic document **601** is translated in accordance with the finger movement from **620-a** to **620-b** so that the top content boundary **601-a** reaches the top edge of the content window **606-a**, and continues to be translated in accordance with the further movement of the finger from **620-b** to **620-c** so that the content boundary **601-a** is pulled inside window edge **606-a**, as shown in FIG. **6C**).

[0344] Optionally, in conjunction with translating the respective portion of the electronic document so that the content boundary is pulled inside the edge of the window, the device displays an additional background in at least a portion of an area (e.g., **601-G** in FIG. **6D** and **607-G** in FIG. **6J**) between the pulled content boundary and the edge of the window, using background adjusting unit **1016**. Optionally, the background adjusting unit **1016** causes the one or more attributes of the additional background to match the corresponding one or more attributes of the background of the electronic document (e.g., in FIG. **6D** the pattern and color of the additional background displayed in **601-G** match the pattern and color of the original background **612** of the electronic document **601**, and in FIG. **6J**, the pattern and color of the additional background displayed in **601-G** match the pattern and color of the original background **670** of the electronic document **607**). Optionally, the background adjusting unit **1016** causes the one or more attributes of the background that are to be matched in the additional background include at least one of a pattern, an orientation, an image, a resolution, a gradient, a shading, a transparency, a size, etc. Optionally, the background adjusting unit **1016** causes the additional background to be generated based on a replication and/or extrapolation of the one or more attributes of the original background.

[0345] Optionally, the device generates the additional background using background adjusting unit **1016** based on the one or more attributes of the original background of the electronic document prior to displaying the additional background in at least the portion of the area (e.g., **601-G** in FIG. **6D** and **607-G** in FIG. **6J**) between the content boundary and the edge of the window. Optionally, the device generates the additional background using background adjusting unit **1016** prior to detecting the scroll input that would cause the content



US 2016/0202865 A1

Jul. 14, 2016

34

boundary to be pulled inside the edge of the window (before the gap area **601-G** in FIG. 6D and **607-G** in FIG. 6J is created), or after detecting such scroll input.

[0346] Optionally, when the device translates the respective portion of the electronic document in the first direction in accordance with the input using translating unit **1014**, the translating unit **1014** causes the device to translate the respective portion of the electronic document in the first direction in a linear relationship with the detected input (e.g., contact movement from **620-a** to **620-b** in FIG. 6B, and contact movement from **640-a** to **640-b** in FIG. 6I) until the content boundary (e.g., **601-a** in FIG. 6B, and **607-a** in FIG. 6I) reaches the edge of the window (e.g., **606-a**). The translating unit **1014** then causes the device to translate the respective portion of the electronic document in the first direction in a non-linear relationship with the detected input as the content boundary (e.g., **601-a** in FIGS. 6C and 6D, and **607-a** in FIG. 6J) is pulled inside the edge of the window (e.g., **606-a**).

[0347] Optionally, while the electronic document is translated in the first direction in the non-linear relationship with the detected input, background adjusting unit **1016** causes the additional background to be displayed in all or at least a portion of the area between the content boundary and the edge of the window (e.g., gap area **601-G** in FIG. 6D and gap area **607-G** in FIG. 6J). The background adjusting unit **1016** causes the size of the portion of the area where the additional background is displayed to increase as the content boundary of the electronic document continues to be pulled further inside the edge of the window.

[0348] Optionally, the electronic document comprises a first object (e.g., object **510** in FIGS. 6A-6L), and the translating unit **1012** causes the first object to remain stationary while the electronic document is translated in the first direction in accordance with the detected scroll input or translated in the second direction after the release of the contact that provided the scroll input. Optionally, while the electronic document is translated without moving the first object, the translating unit **1014** causes a portion of the electronic document to be passed under the first object, and sometimes, the content boundary is slid under the first object so that the first object is pulled out of the content boundary (as shown in FIG. 6D and 6J). Optionally, the translating unit **1014** causes the portion of the electronic document that is passed under the first object to be at least partially visible through the first object from underneath.

[0349] Optionally, the background adjusting unit **1016** causes a respective portion of the window (e.g., menu bar **680** in FIGS. 6G-6L) to change a visual appearance on the display during the scroll movement of the electronic document. Optionally, the background adjusting unit **1016** causes the respective portion of the window to be not transparent (e.g., opaque, or having a low or no transparency) to either the electronic background or the additional background before the device detects the scroll input (e.g., FIG. 6G). Optionally, after the device detects the input and as the respective portion of the electronic document starts moving in the first direction, the background adjusting unit **1016** causes the respective portion of the window (e.g., the menu bar **680** in FIG. 6H) to become transparent to the electronic document but not transparent to the additional background. Optionally, while the content boundary of the electronic document (e.g., an edge of the electronic document **607-a** in FIGS. 6I and 6J) has been translated under the respective portion of the window in accordance with the input (e.g., contact movement from

**640-a** to **640-b** in FIG. 6I and to **640-c** in FIG. 6J), the background adjusting unit **1016** causes the respective portion of the window (e.g., menu bar **680**) to be displayed with an adjusted visual appearance based on an appearance of the electronic document (e.g., **607**) including the background (e.g., **670**) of the electronic document. The adjusted visual appearance of the respective portion of the window creates a visual illusion that there is an additional background under the respective portion of the window that is at least partially seen through the respective portion of the window from underneath (e.g., menu bar **680** in FIGS. 6H-6J). For example, in FIG. 6J, the actual additional background is only displayed in the gap area **607-G**, and not in the area directly under the menu bar **680**, however, the visual effect of the adjusted appearance of the menu bar **680** creates an illusion that the additional background extends into the area under the menu bar **680**.

[0350] Optionally, while the content boundary of the electronic document (e.g., **607-a**) that was adjacent the actual additional background (e.g., in **607-G** in FIG. 6K) is adjacent to the respective portion of the window (e.g., **680**) such that the electronic document is not scrolled under the respective portion of the window (e.g., FIG. 6L), the background adjusting unit **1016** causes the device to display the respective portion of the window (e.g., **680**) without adjustment for the appearance of the additional background (e.g., menu bar **680** in FIG. 6L). For example, the content boundary **607-a** that was previously adjacent the gap **607-G** in FIG. 6K is moved in the upward direction (e.g., **644**) after detection of the end of the input, and the content boundary is adjacent to the respective portion of the window after the restoration behavior of the electronic document is complete after the end of the input (e.g., in FIG. 6L, content boundary **607-a** is adjacent to the menu bar **680**, and the gap area **607-G** is removed). Optionally, the respective portion of the electronic document (e.g., menu bar **680**) has a first value of transparency prior to the detection of the input (e.g., FIG. 6G), and has a second value of transparency higher than the first value after the detection of the input (e.g., FIGS. 6H-6K) during the input-based translation and restoration translation upon the end of the input. Optionally, after the input-based translation and restoration translation of the respective portion of the electronic document is complete, the respective portion of the window (e.g., menu bar **680**) has the first transparency value (e.g., FIG. 6L).

[0351] Optionally, the device detects an end of the input (e.g., a liftoff of the contact from the display) using sensor units **1006**, and determines that the detected state corresponds to an end of the request using request detecting unit **1012**. In response to detecting the end of the input, the device translates, using translation unit **1014**, the respective portion of the electronic document in the second direction opposite the first direction until the content boundary of the electronic document reaches the edge of the window. For example, in FIG. 6E, upon detecting the liftoff of the contact from the display at **620-c**, the respective portion of the electronic document **601** is translated in the second direction **624** opposite the first direction **622** until the content boundary **601-a** reaches window edge **606-a**. This restoration translation of the respective portion of the electronic document **601** in the second direction **624** causes a reduction in size of the gap area in which the additional background is displayed (e.g., the size of the gap **601-G** reduces in accordance with the movement of the electronic document in direction **624**), and the restoration translation continues until the gap area (e.g., **601-G**) is removed

US 2016/0202865 A1

Jul. 14, 2016

35

completely (FIG. 6F). Similarly, in FIG. 6K, upon detecting the liftoff of the contact from the display at 640-c, the translation unit 1014 causes the respective portion of the electronic document 607 to be translated in the second direction 644 opposite the first direction 642 until the content boundary 607-a reaches window edge 606-a. This restoration translation of the respective portion of the electronic document 607 in the second direction 644 causes a reduction in size of the gap area in which the additional background is displayed (e.g., the size of the gap 607-G reduces in accordance with the movement of the electronic document in direction 644), and the restoration translation continues until the gap area (e.g., 601-G) is removed completely (FIG. 6L). Optionally, the respective portion of the electronic document is translated in the second direction, upon the detection of the end of the input that performed the scroll, at a speed faster than a speed at which the respective portion of the electronic document was previously translated in the first direction in accordance with the scroll input.

[0352] It should be noted that details of other functions described herein with respect to other devices and functions blocks of the other devices described herein (e.g., device 900 and its functional blocks) are also applicable in an analogous manner to device 1000 described above with respect to FIG. 10. For example, processing unit 1008, display enabling unit 1010, request detecting unit 1012, translating unit 1014 and background adjusting unit 1016, described above with reference to device 1000 optionally have one or more of the characteristics of the processing unit 908, display enabling unit 910, request detecting unit 912, translating unit 914 and background adjusting unit 916, described herein with reference to other devices described herein (e.g., device 900). For brevity, these details are not repeated here.

[0353] Although examples of this disclosure have been described with reference to the accompanying drawings, it is to be noted that various changes and modifications will become apparent to those skilled in the art. Such changes and modifications are to be understood as being included within the scope of examples of this disclosure as defined by the appended claims.

1. A non-transitory computer readable storage medium storing one or more programs, the one or more programs comprising instructions, which when executed by an electronic device with a display, cause the device to:

display, on the display, an electronic document comprising a first object and a content boundary,

while displaying the electronic document, detect an input corresponding to a request to translate the electronic document in a first direction;

in response to detecting the input corresponding to a request to translate the electronic document, translate a respective portion of the electronic document in the first direction in accordance with the detected input without translating the first object, so that the first object is outside of the content boundary of the electronic document;

after translating the respective portion of the electronic document without translating the first object, detect an end of the input;

in response to detecting the end of the input, translate the respective portion of the electronic document in a second direction different from the first direction without translating the first object, so that the first object is within the content boundary of the electronic document.

2. The non-transitory computer-readable storage medium of claim 1, wherein translating the respective portion of the electronic document in the first direction in accordance with the detected input comprises:

translating the respective portion of the electronic document in the first direction in a linear relationship with the detected input until the content boundary of the electronic document reaches an edge of a window displaying the electronic document; and

translating the respective portion of the electronic document in the first direction in a non-linear relationship with the detected input as the content boundary of the electronic document is pulled inside the edge of the window.

3. The non-transitory computer-readable storage medium of claim 2, wherein:

the display is a touch-sensitive display;

the detected input comprises movement of a finger on the touch-sensitive display;

translating the respective portion of the electronic document in the first direction in a linear relationship with the detected input comprises translating the electronic document in the first direction by an amount that is proportional to the distance moved by the finger on the touch-sensitive display; and

translating the respective portion of the electronic document in the first direction in a non-linear relationship with the detected input comprises translating the electronic document in the first direction by an amount that has a non-linear relationship with the distance moved by the finger on the touch-sensitive display.

4. The non-transitory computer-readable storage medium of claim 2, wherein:

the electronic document further comprises a second object; and

translating the respective portion of the electronic document in the first direction in accordance with the detected input comprises:

maintaining the second object stationary until the content boundary of the electronic document reaches the edge of the window displaying the electronic document; and

translating the second object with the respective portion of the electronic document in the first direction in the non-linear relationship with the detected input as the content boundary of the electronic document is pulled inside the edge of the window.

5. The non-transitory computer-readable storage medium of claim 2, wherein:

the electronic document further comprises a third object; and

translating the respective portion of the electronic document in the first direction in accordance with the detected input comprises:

translating the third object with the respective portion of the electronic document in the first direction in the linear relationship with the detected input until the content boundary of the electronic document reaches the edge of the window; and

translating the third object with the respective portion of the electronic document in the first direction in the non-linear relationship with the detected input as the content boundary of the electronic document is pulled inside the edge of the window.

US 2016/0202865 A1

Jul. 14, 2016

36

6. The non-transitory computer-readable storage medium of claim 2, wherein:

the electronic document further comprises a fourth object; and

translating the respective portion of the electronic document in the first direction in accordance with the detected input comprises:

translating the fourth object with the respective portion of the electronic document in the first direction in the linear relationship with the detected input until the content boundary of the electronic document reaches the edge of the window; and

maintaining the fourth object stationary as the content boundary of the electronic document is pulled inside the edge of the window.

7. The non-transitory computer-readable storage medium of claim 1, wherein the first object is fixed relative to the edge of the window displaying the electronic document.

8. The non-transitory computer-readable storage medium of claim 1, wherein:

translating the respective portion of the electronic document in the first direction in accordance with the detected input without translating the first object comprises passing a portion of the electronic document under the first object.

9. The non-transitory computer-readable storage medium of claim 1, wherein the second direction is opposite the first direction.

10. The non-transitory computer-readable storage medium of claim 1, wherein in response to detecting the end of the input, the respective portion of the electronic document is translated in the second direction at a speed faster than a speed of the translation of the respective portion of the electronic document in the first direction in accordance with the detected input.

11. The non-transitory computer-readable storage medium of claim 1, wherein in response to detecting the end of the input, the respective portion of the electronic document is translated in the second direction until the content boundary of the electronic document reaches the edge of the window.

12. A method, comprising:

at an electronic device with a display:

displaying, on the display, an electronic document comprising a first object and a content boundary,

while displaying the electronic document, detecting an input corresponding to a request to translate the electronic document in a first direction;

in response to detecting the input corresponding to a request to translate the electronic document, translating a respective portion of the electronic document in the first direction in accordance with the detected input without translating the first object, so that the first object is outside of the content boundary of the electronic document;

after translating the respective portion of the electronic document without translating the first object, detecting an end of the input;

in response to detecting the end of the input, translating the respective portion of the electronic document in a second direction different from the first direction without translating the first object, so that the first object is within the content boundary of the electronic document.

13. The method of claim 12, wherein translating the respective portion of the electronic document in the first direction in accordance with the detected input comprises:

translating the respective portion of the electronic document in the first direction in a linear relationship with the detected input until the content boundary of the electronic document reaches an edge of a window displaying the electronic document; and

translating the respective portion of the electronic document in the first direction in a non-linear relationship with the detected input as the content boundary of the electronic document is pulled inside the edge of the window.

14. The method of claim 13, wherein:

the display is a touch-sensitive display;

the detected input comprises movement of a finger on the touch-sensitive display;

translating the respective portion of the electronic document in the first direction in a linear relationship with the detected input comprises translating the electronic document in the first direction by an amount that is proportional to the distance moved by the finger on the touch-sensitive display; and

translating the respective portion of the electronic document in the first direction in a non-linear relationship with the detected input comprises translating the electronic document in the first direction by an amount that has a non-linear relationship with the distance moved by the finger on the touch-sensitive display.

15. The method of claim 13, wherein:

the electronic document further comprises a second object; and

translating the respective portion of the electronic document in the first direction in accordance with the detected input comprises:

maintaining the second object stationary until the content boundary of the electronic document reaches the edge of the window displaying the electronic document; and

translating the second object with the respective portion of the electronic document in the first direction in the non-linear relationship with the detected input as the content boundary of the electronic document is pulled inside the edge of the window.

16. The method of claim 13, wherein:

the electronic document further comprises a third object; and

translating the respective portion of the electronic document in the first direction in accordance with the detected input comprises:

translating the third object with the respective portion of the electronic document in the first direction in the linear relationship with the detected input until the content boundary of the electronic document reaches the edge of the window; and

translating the third object with the respective portion of the electronic document in the first direction in the non-linear relationship with the detected input as the content boundary of the electronic document is pulled inside the edge of the window.

17. The method of claim 13, wherein:

the electronic document further comprises a fourth object; and

US 2016/0202865 A1

Jul. 14, 2016

37

translating the respective portion of the electronic document in the first direction in accordance with the detected input comprises:

translating the fourth object with the respective portion of the electronic document in the first direction in the linear relationship with the detected input until the content boundary of the electronic document reaches the edge of the window; and

maintaining the fourth object stationary as the content boundary of the electronic document is pulled inside the edge of the window.

**18.** The method of claim **12**, wherein the first object is fixed relative to the edge of the window displaying the electronic document.

**19.** The method of claim **12**, wherein

translating the respective portion of the electronic document in the first direction in accordance with the detected input without moving the first object comprises passing a portion of the electronic document under the first object.

**20.** The method of claim **12**, wherein the second direction is opposite the first direction.

**21.** The method of claim **12**, wherein

in response to detecting the end of the input, the respective portion of the electronic document is translated in the second direction at a speed faster than a speed of the translation of the respective portion of the electronic document in the first direction in accordance with the detected input.

**22.** The method of claim **12**, wherein in response to detecting the end of the input, the respective portion of the electronic document is translated in the second direction until the content boundary of the electronic document reaches the edge of the window.

**23.** An electronic device, comprising:

a display;

a memory; and

one or more processors coupled to the display and the memory, the one or more processors configured to:

display, on the display, an electronic document comprising a first object and a content boundary,

while displaying the electronic document, detect an input corresponding to a request to translate the electronic document in a first direction;

in response to detecting the input corresponding to a request to translate the electronic document, translate a respective portion of the electronic document in the first direction in accordance with the detected input without translating the first object, so that the first object is outside of the content boundary of the electronic document;

after translating the respective portion of the electronic document without translating the first object, detect an end of the input;

in response to detecting the end of the input, translate the respective portion of the electronic document in a second direction different from the first direction without translating the first object, so that the first object is within the content boundary of the electronic document.

**24.** The device of claim **23**, wherein translating the respective portion of the electronic document in the first direction in accordance with the detected input comprises:

translating the respective portion of the electronic document in the first direction in a linear relationship with the detected input until the content boundary of the electronic document reaches an edge of a window displaying the electronic document; and

translating the respective portion of the electronic document in the first direction in a non-linear relationship with the detected input as the content boundary of the electronic document is pulled inside the edge of the window.

**25.** The device of claim **24**, wherein:

the display is a touch-sensitive display;

the detected input comprises movement of a finger on the touch-sensitive display;

translating the respective portion of the electronic document in the first direction in a linear relationship with the detected input comprises translating the electronic document in the first direction by an amount that is proportional to the distance moved by the finger on the touch-sensitive display; and

translating the respective portion of the electronic document in the first direction in a non-linear relationship with the detected input comprises translating the electronic document in the first direction by an amount that has a non-linear relationship with the distance moved by the finger on the touch-sensitive display.

**26.** The device of claim **24**, wherein:

the electronic document further comprises a second object; and

translating the respective portion of the electronic document in the first direction in accordance with the detected input comprises:

maintaining the second object stationary until the content boundary of the electronic document reaches the edge of the window displaying the electronic document; and

translating the second object with the respective portion of the electronic document in the first direction in the non-linear relationship with the detected input as the content boundary of the electronic document is pulled inside the edge of the window.

**27.** The device of claim **24**, wherein:

the electronic document further comprises a third object; and

translating the respective portion of the electronic document in the first direction in accordance with the detected input comprises:

translating the third object with the respective portion of the electronic document in the first direction in the linear relationship with the detected input until the content boundary of the electronic document reaches the edge of the window; and

translating the third object with the respective portion of the electronic document in the first direction in the non-linear relationship with the detected input as the content boundary of the electronic document is pulled inside the edge of the window.

**28.** The device of claim **24**, wherein:

the electronic document further comprises a fourth object; and

translating the respective portion of the electronic document in the first direction in accordance with the detected input comprises:



US 2016/0202865 A1

Jul. 14, 2016

38

translating the fourth object with the respective portion of the electronic document in the first direction in the linear relationship with the detected input until the content boundary of the electronic document reaches the edge of the window; and  
maintaining the fourth object stationary as the content boundary of the electronic document is pulled inside the edge of the window.

**29.** The device of claim **23**, wherein the first object is fixed relative to the edge of the window displaying the electronic document.

**30.** The device of claim **23**, wherein:  
translating the respective portion of the electronic document in the first direction in accordance with the detected input without moving the first object comprises passing a portion of the electronic document under the first object.

**31.** The device of claim **23**, wherein the second direction is opposite the first direction.

**32.** The device of claim **23**, wherein  
in response to detecting the end of the input, the respective portion of the electronic document is translated in the second direction at a speed faster than a speed of the translation of the respective portion of the electronic document in the first direction in accordance with the detected input.

**33.** The device of claim **23**, wherein  
in response to detecting the end of the input, the respective portion of the electronic document is translated in the second direction until the content boundary of the electronic document reaches the edge of the window.

\* \* \* \* \*



# **EXHIBIT 12**

PATENTS  
P7276USC1

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Inventors : Gloria Lin et al.  
Application No. : 14/136,658 Confirmation No.: 2657  
Filed : December 20, 2013  
For : SEAMLESSLY EMBEDDED HEART RATE MONITOR  
Art Unit : 3762  
Examiner : Alyssa Margo Alter Morschauser

New York, New York 10013  
January 15, 2018

Commissioner for Patents  
P.O. Box 1450  
Alexandria, Virginia 22313-1450

REPLY TO NON-FINAL OFFICE ACTION

Sir:

This is in response to the Non-Final Office Action mailed September 14, 2017 (hereinafter "the Office Action"). Applicant hereby responds as follows:

**A Listing of Claims** begins on page 2 of this paper; and

**Remarks** begin on page 9 of this paper.

Application No. 14/136,658 (Attorney Docket No.: P7276USC1)

Reply dated January 15, 2018

Reply to Non-Final Office Action of September 4, 2017

Listing of Claims:

1. - 23. (Cancelled)

24. (Withdrawn) An electronic device comprising:  
a bezel, wherein an outer surface of at least a portion of the bezel comprises a first visual characteristic; and  
a heart sensor coupled to the at least a portion of the bezel and operative to detect a user's cardiac signal, wherein an outer surface of the heart sensor comprises a second visual characteristic that matches the first visual characteristic.

25. (Withdrawn) The electronic device of claim 24, wherein each of the outer surface of the at least a portion of the bezel and the outer surface of the heart sensor comprises a portion of an outer surface of the electronic device.

26. (Withdrawn) The electronic device of claim 24, wherein:  
the outer surface of the at least a portion of the bezel comprises a first finish; and  
the outer surface of the heart sensor comprises a second finish that matches the first finish.

27. (Withdrawn) The electronic device of claim 24, wherein the outer surface of the heart sensor comprises a conductive coating that provides the second visual characteristic.

28. (Withdrawn) The electronic device of claim 24, wherein each of the first visual characteristic and the second visual characteristic comprises at least one of:  
a particular color;

Application No. 14/136,658 (Attorney Docket No.: P7276USC1)

Reply dated January 15, 2018

Reply to Non-Final Office Action of September 4, 2017

a particular tone; and  
a particular reflectivity.

29. (Previously Presented) An electronic device for detecting a user's cardiac signal, comprising:

an enclosure;

a heart sensor configured to detect the user's cardiac signal, the heart sensor comprising:

a first lead comprising a first pad that is embedded in a first portion of the enclosure, wherein an exterior surface of the enclosure comprises an exterior surface of the first portion, wherein the first pad is positioned underneath the exterior surface of the first portion, and wherein the first pad is configured to detect a first electrical signal of the user's cardiac signal via the user's skin's contact with the exterior surface of the first portion of the enclosure; and

a second lead comprising a second pad that is embedded in a second portion of the enclosure, wherein the second pad is configured to detect a second electrical signal of the user's cardiac signal via the user's skin's contact with at least one of the second pad and the second portion of the enclosure; and

a processor coupled to the heart sensor and configured to receive and process the detected cardiac signal, wherein the first lead further comprises a first connector coupled to the first pad and configured to provide the first electrical signal detected by the first pad to the processor, and wherein the second lead further comprises a second connector coupled to the second pad and configured to provide the second electrical signal detected by the second pad to the processor.

Application No. 14/136,658 (Attorney Docket No.: P7276USC1)

Reply dated January 15, 2018

Reply to Non-Final Office Action of September 4, 2017

30. (Previously Presented) The electronic device of claim 29, wherein the first portion and the second portion are located on opposite sides of the electronic device.

31. (Previously Presented) The electronic device of claim 29, wherein the first portion is electrically isolated from the second portion.

32. (Previously Presented) The electronic device of claim 29, wherein:

the first portion is separated from the second portion by a third portion of the enclosure;

at least the third portion is constructed from a material having a first conductivity; and

the first conductivity is insufficient to transmit the first electrical signal from the first pad to the second pad via the third portion.

33. (Previously Presented) The electronic device of claim 32, wherein:

the material having the first conductivity comprises one of aluminum and steel; and

the second pad is constructed from a silver based compound.

34. (Previously Presented) The electronic device of claim 32, wherein:

the exterior surface of the enclosure further comprises an exterior surface of the second portion;

the second pad is configured to detect the second electrical signal of the user's cardiac signal via the user's contact



Application No. 14/136,658 (Attorney Docket No.: P7276USC1)

Reply dated January 15, 2018

Reply to Non-Final Office Action of September 4, 2017

with the exterior surface of the second portion;

the second pad is positioned from the exterior surface of the second portion by a thickness of the second portion;

at least the thickness of the second portion is constructed from material having a second conductivity; and

the second conductivity is defined such that the second electrical signal is not able to be transmitted through material having the second conductivity over a distance larger than the thickness of the second portion.

35. (Previously Presented) The electronic device of claim 34, wherein the first pad and the second pad are positioned apart from one another at a distance larger than the thickness of the second portion by material having the second conductivity.

36. (Previously Presented) The electronic device of claim 29, wherein:

the enclosure further comprises at least one pocket underneath the exterior surface of the enclosure; and

at least one of the first pad and the second pad is placed within the at least one pocket.

37. (Cancelled)

38. (Cancelled)

39. (Previously Presented) The electronic device of claim 29, further comprising:

a display, wherein the enclosure supports the display, and wherein at least a portion of the exterior surface of the enclosure forms at least a portion of an exterior surface of the

Application No. 14/136,658 (Attorney Docket No.: P7276USC1)

Reply dated January 15, 2018

Reply to Non-Final Office Action of September 4, 2017

electronic device behind the display; and

a third lead embedded with the display, wherein the third lead is configured to detect a third electrical signal of the user's cardiac signal via the user's contact with at least one of the third lead and the display.

40. (Previously Presented) An electronic device for detecting a user's cardiac signal, comprising:

an enclosure;

a display screen exposed to the user through an opening in the enclosure;

a heart sensor configured to detect the user's cardiac signal, the heart sensor comprising:

a first lead embedded in a first portion of the enclosure of the electronic device, wherein the first lead is configured to detect a first electrical signal of the user's cardiac signal via the user's contact with at least one of the first lead and the first portion of the enclosure of the electronic device; and

a second lead embedded in the display screen of the electronic device, wherein the second lead is configured to detect a second electrical signal of the user's cardiac signal via the user's contact with at least one of the second lead and the display screen of the electronic device; and

a processor coupled to the heart sensor and configured to process the first and second electrical signals of the user's cardiac signal.

41. (Cancelled)

42. (Previously Presented) The electronic device of claim 40, wherein:

Application No. 14/136,658 (Attorney Docket No.: P7276USC1)

Reply dated January 15, 2018

Reply to Non-Final Office Action of September 4, 2017

the first portion of the electronic device comprises a bezel of the enclosure;

the electronic device further comprises a non-conductive component positioned between the bezel and the display screen for electrically isolating the first lead from the second lead.

43. (Cancelled)

44. (Previously Presented) The electronic device of claim 29, wherein the second lead is configured to detect the second electrical signal of the user's cardiac signal via the user's contact with the second portion of the enclosure.

45. (Previously Presented) The electronic device of claim 29, wherein the second lead is configured to detect the second electrical signal of the user's cardiac signal via the user's contact with the second lead.

46. (Previously Presented) The electronic device of claim 40, wherein the first lead is configured to detect the first electrical signal of the user's cardiac signal via the user's contact with the first lead.

47. (Previously Presented) The electronic device of claim 46, wherein the second lead is configured to detect the second electrical signal of the user's cardiac signal via the user's contact with the second lead.

48. (Previously Presented) The electronic device of claim 46, wherein the second lead is configured to detect the second

Application No. 14/136,658 (Attorney Docket No.: P7276USC1)

Reply dated January 15, 2018

Reply to Non-Final Office Action of September 4, 2017

electrical signal of the user's cardiac signal via the user's contact with the display screen.

49. (Previously Presented) The electronic device of claim 40, wherein the first lead is configured to detect the first electrical signal of the user's cardiac signal via the user's contact with the first portion of the enclosure.

50. (Previously Presented) The electronic device of claim 49, wherein the second lead is configured to detect the second electrical signal of the user's cardiac signal via the user's contact with the second lead.

51. (Previously Presented) The electronic device of claim 49, wherein the second lead is configured to detect the second electrical signal of the user's cardiac signal via the user's contact with the display screen.

52. (Previously Presented) The electronic device of claim 29, wherein the first portion of the enclosure is a bezel.

53. (Previously Presented) The electronic device of claim 29, wherein the second portion of the enclosure is a bezel.

54. (Previously Presented) The electronic device of claim 29, wherein an interior surface of the enclosure comprises an interior surface of the first portion, wherein the first pad is positioned on the interior surface of the first portion.

Application No. 14/136,658 (Attorney Docket No.: P7276USC1)

Reply dated January 15, 2018

Reply to Non-Final Office Action of September 4, 2017

## REMARKS

### Introduction

Claims 1-23, 37, 38, 41, and 43 have been cancelled without prejudice. Applicant hereby reserves the right to pursue the subject matter of any cancelled claims in one or more continuation applications. Claims 24-28 have been withdrawn without prejudice. Claims 29-36, 39, 40, 42, and 44-54 are also currently pending in the above-identified patent application. No new subject matter has been introduced and all amendments are fully supported by the application as originally filed.

Claims 29-36 and 40<sup>1</sup> have been rejected under 35 U.S.C. § 102 as allegedly being anticipated by Weiss U.S. Patent No. 5,623,926 (hereinafter "Weiss").

A one-month extension of time in which to respond to the Non-Final Office Action mailed September 14, 2017 is respectfully requested. The required fee is being paid by credit card, but the Director is authorized to charge any underpayment or to credit any overpayment to Deposit Account No. 50-6007.

Reconsideration and allowance of this application in light of the following remarks is hereby respectfully requested.

### The Rejections Under 35 U.S.C. § 102

#### Claims 29-36

Claims 29-36 have been rejected under 35 U.S.C. § 102 as allegedly being anticipated by Weiss. These rejections are respectfully traversed.

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<sup>1</sup> Applicant respectfully notes that none of applicant's claims 39, 42, and 44-54 are referenced in the Office Action. Therefore, applicant assumes that each one of applicant's claims 39, 42, and 44-54 are dependent upon a rejected base claim but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims. Confirmation by the Examiner of this assumption is respectfully requested.



Application No. 14/136,658 (Attorney Docket No.: P7276USC1)

Reply dated January 15, 2018

Reply to Non-Final Office Action of September 4, 2017

Applicant's independent claim 29 defines an electronic device for detecting a user's cardiac signal, including an enclosure, a heart sensor configured to detect the user's cardiac signal, and a processor coupled to the heart sensor. The heart sensor includes a first lead including a first pad that is embedded in a first portion of the enclosure, wherein an exterior surface of the enclosure includes an exterior surface of the first portion, wherein the first pad is positioned underneath the exterior surface of the first portion, and wherein the first pad is configured to detect a first electrical signal of the user's cardiac signal via the user's skin's contact with the exterior surface of the first portion of the enclosure. The heart sensor also includes a second lead including a second pad that is embedded in a second portion of the enclosure, wherein the second pad is configured to detect a second electrical signal of the user's cardiac signal via the user's skin's contact with at least one of the second pad and the second portion of the enclosure. The processor is configured to receive and process the detected cardiac signal, wherein the first lead further includes a first connector coupled to the first pad and configured to provide the first electrical signal detected by the first pad to the processor, and wherein the second lead further includes a second connector coupled to the second pad and configured to provide the second electrical signal detected by the second pad to the processor.

For example, "[h]eart sensor 112 can include one or more leads connected to the exterior of the electronic device such that the user may contact one or more of the leads to provide an electrical signal associated with the user's heart to heart sensor 112," and "[t]he cardiac signals detected by the heart sensor leads can be coupled to a processor incorporated in heart sensor 112, or instead provided to processor 102," where "[t]he processor may then analyze the received signals and generate, from the received

Application No. 14/136,658 (Attorney Docket No.: P7276USC1)

Reply dated January 15, 2018

Reply to Non-Final Office Action of September 4, 2017

signals, one or more characteristic quantities of the user's heartbeat or heart rate for authentication" (applicant's specification, paragraph [0033]). The "size and location of the leads can be selected to ensure that sufficient contact is made between the user (e.g., the user's hand or finger) and the leads for cardiac signals to be detected," where "each lead can include a pad or extended area placed on the outer or inner surface of an electronic device bezel or housing" or "an entire portion of the electronic device enclosure (e.g., a portion of a bezel or housing) can serve as a lead for the heart sensor," and the "pad or extended area can then be coupled to a wire or other connector for providing cardiac signals to a processor for processing" (applicant's specification, paragraph [0034]), such as leads 322 and 324 of FIG. 3. As a specific example, with respect to applicant's FIG. 4B, an enclosure of electronic device 450 may include a bezel 460, where, "[i]f the electrical conductivity and size of bezel 460, and the strength or characteristics of the cardiac signal provided by the user and detected by the heart sensor are adapted such that the signal can be transmitted along short distances in bezel 460, lead 472 of the heart sensor can be positioned against the back surface of bezel 460," or "lead 472 can be placed within the thickness of bezel 460 (e.g., in a pocket within the bezel wall), but underneath the outer surface of the bezel," where a "short thickness of bezel 460 can allow electrical signals to propagate from the user to the outer surface of bezel 460, through bezel 460, and into lead 472, which may in turn transmit the signals to a processor using connector 474" (applicant's specification, paragraph [0047]).

Weiss is directed towards an ECG monitor 16 that includes a bottom case 14 of a housing, where an LCD display is provided at an opposite case (i.e., a top case) of the housing. Weiss' ECG monitor 16 also includes a swing arm assembly 10 rotatably mounted on

Application No. 14/136,658 (Attorney Docket No.: P7276USC1)

Reply dated January 15, 2018

Reply to Non-Final Office Action of September 4, 2017

the bottom case 14, where sensing electrodes 12 are mounted on the swing arm assembly 10 to allow for variable positioning of the sensing electrodes 12 relative to the display when the swing arm assembly 10 rotates with respect to the bottom case 14.

Nowhere does Weiss show or suggest an electronic device with an enclosure and a heart sensor with "a first pad [that is] embedded in a first portion of the enclosure" and a "second pad [that is] embedded in a second portion of the enclosure," where "an exterior surface of the enclosure comprises an exterior surface of the first portion, wherein the first pad is positioned underneath the exterior surface of the first portion, and wherein the first pad is configured to detect a first electrical signal of the user's cardiac signal via the user's skin's contact with the exterior surface of the first portion of the enclosure," as required by applicant's independent claim 29. That is, nowhere does Weiss show or suggest that any electrode 12 is embedded in any portion of case 14 of the housing of ECG monitor 16 or in any portion of swing arm assembly 10 of ECG monitor 16, let alone show or suggest that any electrode 12 is "positioned underneath [an] exterior surface of" a portion of case 14 or swing arm assembly 10 such that the electrode 12 is "configured to detect a first electrical signal of [a] user's cardiac signal via the user's skin's contact with [such an] exterior surface" of case 14 or swing arm assembly 10. Instead, each one of Weiss' electrodes 12 is "mounted on" swing arm assembly 10 (Weiss, column 1, line 54), where an outermost piece 46 of each one of Weiss' electrodes 12 "contacts the skin" of the user (Weiss, column 3, line 7).

For at least these reasons, applicant respectfully submits that applicant's independent claim 29 and all claims dependent therefrom, including claims 30-36, 39, 44, 45, and 52-54, are allowable over Weiss. Therefore, applicant respectfully requests

Application No. 14/136,658 (Attorney Docket No.: P7276USC1)

Reply dated January 15, 2018

Reply to Non-Final Office Action of September 4, 2017

that the rejections of claims 29-36 under 35 U.S.C. § 102 be withdrawn.

Claim 40

Claim 40 has been rejected under 35 U.S.C. § 102 as allegedly being anticipated by Weiss. This rejection is respectfully traversed.

Applicant's independent claim 40 defines an electronic device for detecting a user's cardiac signal, including an enclosure, a display screen exposed to the user through an opening in the enclosure, a heart sensor configured to detect the user's cardiac signal, and a processor coupled to the heart sensor. The heart sensor includes a first lead embedded in a first portion of the enclosure of the electronic device, wherein the first portion of the electronic device comprises an enclosure of the electronic device, wherein the first lead is configured to detect a first electrical signal of the user's cardiac signal via the user's contact with at least one of the first lead and the first portion of the enclosure of the electronic device. The heart sensor also includes a second lead embedded in the display screen of the electronic device, wherein the second lead is configured to detect a second electrical signal of the user's cardiac signal via the user's contact with at least one of the second lead and the display screen of the electronic device. The processor is configured to process the first and second electrical signals of the user's cardiac signal.

For example, as shown in applicant's FIG. 3, "electronic device 300 can include additional lead 326 embedded in or behind display 302," where "[l]ead 326 can be operative to detect a user's heart activity as the user moves a finger across display 302," and, "[u]sing lead 326, the electronic device can detect an electrical signal from a different portion of the user's body (e.g., leads 322

Application No. 14/136,658 (Attorney Docket No.: P7276USC1)

Reply dated January 15, 2018

Reply to Non-Final Office Action of September 4, 2017

and 324 detect signals through a first hand, and lead 326 detects signals through the second hand), which can provide the processor with additional information for determining characteristics of the user's cardiac activity" (applicant's specification, paragraph [0043]).

Weiss is directed towards an ECG monitor 16 that includes a bottom case 14 of a housing, where an LCD display is provided at an opposite case (i.e., a top case) of the housing. Weiss' ECG monitor 16 also includes a swing arm assembly 10 rotatably mounted on the bottom case 14, where sensing electrodes 12 are mounted on the swing arm assembly 10 to allow for variable positioning of the sensing electrodes 12 relative to the display when the swing arm assembly 10 rotates with respect to the bottom case 14.

Nowhere does Weiss show or suggest an electronic device with a heart sensor that includes "a first lead embedded in a first portion of [an] enclosure of the electronic device," as well as "a second lead embedded in [a] display screen [exposed to the user through an opening in the enclosure] of the electronic device, wherein the second lead is configured to detect a second electrical signal of the user's cardiac signal via the user's contact with at least one of the second lead and the display screen of the electronic device," as required by applicant's independent claim 40. That is, nowhere does Weiss show or suggest that a first one of electrodes 12 is embedded in case 14 or swing arm assembly 10 and that a second one of electrodes 12 is embedded in a display screen exposed to a user through an opening in case 14 or swing arm assembly 10. In fact, nowhere does Weiss show or suggest that any electrode 12 is "embedded in the display screen" of ECG monitor 16, let alone show or suggest that such an electrode 12 is configured to "detect a second electrical signal of the user's cardiac signal" via the user's contact with at least one of such an electrode 12 and the display



Application No. 14/136,658 (Attorney Docket No.: P7276USC1)

Reply dated January 15, 2018

Reply to Non-Final Office Action of September 4, 2017

screen. In fact, Weiss teaches away from such an electronic device of applicant's independent claim 40, as Weiss provides each sensing electrode 12 on swing assembly 10 that "allows for variable positioning of the sensing electrodes relative to the display" of ECG monitor 16 (Weiss, column 1, lines 25-27).

For at least these reasons, applicant respectfully submits that applicant's independent claim 40 and all claims dependent therefrom, including claims 42 and 46-51, are allowable. Therefore, applicant respectfully requests that the rejection of claim 40 under 35 U.S.C. § 102 be withdrawn.

#### Conclusion

In view of the foregoing, applicant respectfully submits that claims 29-36, 39, 40, 42, and 44-54 are allowable. This application is therefore in condition for allowance. Reconsideration and prompt allowance of this application are respectfully requested.

Respectfully submitted,

Date: January 15, 2018

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# **EXHIBIT 13**

PATENTS  
P7276USC1

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicants : Gloria Lin et al.  
Application No. : 14/136,658 Confirmation No.: 2657  
Filed : December 20, 2013  
For : SEAMLESSLY EMBEDDED HEART RATE MONITOR  
Art Unit : 3762  
Examiner : Alyssa Margo Alter Morschauser

New York, New York 10013  
September 2, 2016

Commissioner for Patents  
P.O. Box 1450  
Alexandria, Virginia 22313-1450

REPLY TO FINAL OFFICE ACTION

Sir:

This is in response to the Final Office Action mailed March 2, 2016 (hereinafter "the Office Action"). Applicants hereby respond as follows:

**Amendments to the Claims** are reflected in the listing of claims which begins on page 2 of this paper; and

**Remarks** begin on page 10 of this paper.

Application No. 14/136,658 (Attorney Docket No.: P7276USC1)

Reply dated September 2, 2016

Reply to Final Office Action of March 2, 2016

Amendments to the Claims

This listing of claims will replace all prior versions and listings of claims in the application:

Listing of Claims:

1. - 23. (Cancelled)

24. (Withdrawn) An electronic device comprising:  
a bezel, wherein an outer surface of at least a portion of the bezel comprises a first visual characteristic; and  
a heart sensor coupled to the at least a portion of the bezel and operative to detect a user's cardiac signal, wherein an outer surface of the heart sensor comprises a second visual characteristic that matches the first visual characteristic.

25. (Withdrawn) The electronic device of claim 24, wherein each of the outer surface of the at least a portion of the bezel and the outer surface of the heart sensor comprises a portion of an outer surface of the electronic device.

26. (Withdrawn) The electronic device of claim 24, wherein:  
the outer surface of the at least a portion of the bezel comprises a first finish; and  
the outer surface of the heart sensor comprises a second finish that matches the first finish.

27. (Withdrawn) The electronic device of claim 24, wherein the outer surface of the heart sensor comprises a conductive coating that provides the second visual characteristic.

Application No. 14/136,658 (Attorney Docket No.: P7276USC1)

Reply dated September 2, 2016

Reply to Final Office Action of March 2, 2016

28. (Withdrawn) The electronic device of claim 24, wherein each of the first visual characteristic and the second visual characteristic comprises at least one of:

- a particular color;
- a particular tone; and
- a particular reflectivity.

29. (Currently Amended) An electronic device for detecting a user's cardiac signal, comprising:

an enclosure;

a heart sensor configured to detect the user's cardiac signal, the heart sensor comprising:

a first lead comprising a first pad that is embedded in a first portion of the enclosure, wherein an exterior surface of the enclosure comprises an exterior surface of the first portion, wherein the first ~~lead~~ pad is positioned underneath the exterior surface of the first portion, and wherein the first ~~lead~~ pad is configured to detect a first electrical signal of the user's cardiac signal via the user's skin's contact with the exterior surface of the first portion of the enclosure; and

a second lead comprising a second pad that is embedded in a second portion of the enclosure, wherein the second ~~lead~~ pad is configured to detect a second electrical signal of the user's cardiac signal via the user's skin's contact with at least one of the second ~~lead~~ pad and the second portion of the enclosure; and

a processor coupled to the heart sensor and configured to receive and process the detected cardiac signal, wherein the first lead further comprises a first connector coupled to the first pad and configured to provide the first electrical signal detected by the first pad to the processor, and wherein the second lead further comprises a second connector coupled to the second pad and configured



Application No. 14/136,658 (Attorney Docket No.: P7276USC1)

Reply dated September 2, 2016

Reply to Final Office Action of March 2, 2016

to provide the second electrical signal detected by the second pad to the processor.

30. (Previously Presented) The electronic device of claim 29, wherein the first portion and the second portion are located on opposite sides of the electronic device.

31. (Previously Presented) The electronic device of claim 29, wherein the first portion is electrically isolated from the second portion.

32. (Currently Amended) The electronic device of claim 29, wherein:

the first portion is separated from the second portion by a third portion of the enclosure;

at least the third portion is constructed from a material having a first conductivity; and

the first conductivity is insufficient to transmit the first electrical signal from the first ~~lead~~ pad to the second ~~lead~~ pad via the third portion.

33. (Currently Amended) The electronic device of claim 32, wherein:

the material having the first conductivity comprises one of aluminum and steel; and

the second ~~lead~~ pad is constructed from a silver based compound.

34. (Currently Amended) The electronic device of claim 32, wherein:

the exterior surface of the enclosure further

Application No. 14/136,658 (Attorney Docket No.: P7276USC1)

Reply dated September 2, 2016

Reply to Final Office Action of March 2, 2016

comprises an exterior surface of the second portion;

the second ~~lead~~ pad is configured to detect the second electrical signal of the user's cardiac signal via the user's contact with the exterior surface of the second portion;

the second ~~lead~~ pad is positioned from the exterior surface of the second portion by a thickness of the second portion;

at least the thickness of the second portion is constructed from material having a second conductivity; and

the second conductivity is defined such that the second electrical signal is not able to be transmitted through material having the second conductivity over a distance larger than the thickness of the second portion.

35. (Currently Amended) The electronic device of claim 34, wherein the first ~~lead~~ pad and the second ~~lead~~ pad are positioned apart from one another at a distance larger than the thickness of the second portion by material having the second conductivity.

36. (Currently Amended) The electronic device of claim 29, wherein:

the enclosure further comprises at least one pocket underneath the exterior surface of the enclosure; and

at least one of the first ~~lead~~ pad and the second ~~lead~~ pad is placed within the at least one pocket.

37. (Cancelled)

38. (Cancelled)

39. (Previously Presented) The electronic device of claim 29, further comprising:

Application No. 14/136,658 (Attorney Docket No.: P7276USC1)

Reply dated September 2, 2016

Reply to Final Office Action of March 2, 2016

a display, wherein the enclosure supports the display, and wherein at least a portion of the exterior surface of the enclosure forms at least a portion of an exterior surface of the electronic device behind the display; and

a third lead embedded with the display, wherein the third lead is configured to detect a third electrical signal of the user's cardiac signal via the user's contact with at least one of the third lead and the display.

40. (Currently Amended) An electronic device for detecting a user's cardiac signal, comprising:

an enclosure;

a display screen exposed to the user through an opening in the enclosure;

a heart sensor configured to detect the user's cardiac signal, the heart sensor comprising:

a first lead embedded in a first portion of the enclosure of the electronic device, wherein the first lead is configured to detect a first electrical signal of the user's cardiac signal via the user's contact with at least one of the first lead and the first portion of the enclosure of the electronic device; and

a second lead embedded in ~~a second portion~~ the display screen of the electronic device, wherein the second lead is configured to detect a second electrical signal of the user's cardiac signal via the user's contact with at least one of the second lead and the ~~second portion~~ display screen of the electronic device; and

a processor coupled to the heart sensor and configured to process the first and second electrical signals of the user's cardiac signal, ~~wherein:~~

~~the first portion of the electronic device comprises an enclosure of the electronic device; and~~

Application No. 14/136,658 (Attorney Docket No.: P7276USC1)

Reply dated September 2, 2016

Reply to Final Office Action of March 2, 2016

~~the second portion of the electronic device comprises a display screen exposed to the user through an opening in the enclosure of the electronic device.~~

41. (Cancelled)

42. (Currently Amended) The electronic device of claim 40, wherein:

the first portion of the electronic device comprises a bezel of the enclosure;

the electronic device further comprises a non-conductive component positioned between the bezel and the display screen for electrically isolating the first ~~portion of the electronic device~~ lead from the second ~~portion of the electronic device~~ lead.

43. (Cancelled)

44. (New) The electronic device of claim 29, wherein the second lead is configured to detect the second electrical signal of the user's cardiac signal via the user's contact with the second portion of the enclosure.

45. (New) The electronic device of claim 29, wherein the second lead is configured to detect the second electrical signal of the user's cardiac signal via the user's contact with the second lead.

46. (New) The electronic device of claim 40, wherein the first lead is configured to detect the first electrical signal of the user's cardiac signal via the user's contact with the first lead.

Application No. 14/136,658 (Attorney Docket No.: P7276USC1)

Reply dated September 2, 2016

Reply to Final Office Action of March 2, 2016

47. (New) The electronic device of claim 46, wherein the second lead is configured to detect the second electrical signal of the user's cardiac signal via the user's contact with the second lead.

48. (New) The electronic device of claim 46, wherein the second lead is configured to detect the second electrical signal of the user's cardiac signal via the user's contact with the display screen.

49. (New) The electronic device of claim 40, wherein the first lead is configured to detect the first electrical signal of the user's cardiac signal via the user's contact with the first portion of the enclosure.

50. (New) The electronic device of claim 49, wherein the second lead is configured to detect the second electrical signal of the user's cardiac signal via the user's contact with the second lead.

51. (New) The electronic device of claim 49, wherein the second lead is configured to detect the second electrical signal of the user's cardiac signal via the user's contact with the display screen.

52. (New) The electronic device of claim 29, wherein the first portion of the enclosure is a bezel.

53. (New) The electronic device of claim 29, wherein the second portion of the enclosure is a bezel.



Application No. 14/136,658 (Attorney Docket No.: P7276USC1)

Reply dated September 2, 2016

Reply to Final Office Action of March 2, 2016

54. (New) The electronic device of claim 29, wherein an interior surface of the enclosure comprises an interior surface of the first portion, wherein the first pad is positioned on the interior surface of the first portion.

Application No. 14/136,658 (Attorney Docket No.: P7276USC1)  
Reply dated September 2, 2016  
Reply to Final Office Action of March 2, 2016

## REMARKS

### Introduction

Claims 1-23, 37, 38, 41, and 43 have been cancelled without prejudice. Applicants hereby reserve the right to pursue the subject matter of one or more of cancelled claims in one or more continuation applications. Claims 24-28 have been withdrawn without prejudice. Claims 44-54 have been added. Claims 29, 32-36, 40, and 42 have been amended. Claims 30, 31, and 39 are also currently pending in the above-identified patent application. No new subject matter has been introduced and all amendments are fully supported by the application as originally filed.

Claims 29-32 and 36 have been rejected under 35 U.S.C. § 102(b) as allegedly being anticipated by Gilles et al. U.S. Patent No. 4,635,646 (hereinafter "Gilles").

Claims 33-35, 39, 40, and 42 have been rejected under 35 U.S.C. § 103(a) as allegedly being unpatentable over Gilles.

A three-month extension of time in which to respond to the Final Office Action mailed March 2, 2016 is respectfully requested. It is noted that a one-month extension was previously requested and paid for with the Reply filed June 30, 2016. The required fees are being paid by credit card, but the Director is authorized to charge any underpayment or to credit any overpayment to Deposit Account No. 50-6007.

Reconsideration and allowance of this application in light of the following remarks is hereby respectfully requested.

### Summary of Examiner Interview

Applicants would like to thank the Examiner for the many courtesies extended during the interview of August 18, 2016 with the undersigned and the interview of August 23, 2016 with the undersigned (herein after "the Examiner Interviews"). During the interviews, the

Application No. 14/136,658 (Attorney Docket No.: P7276USC1)

Reply dated September 2, 2016

Reply to Final Office Action of March 2, 2016

currently amended claims were discussed in light of the cited references.

The Rejections Under 35 U.S.C. § 102(b)

Claims 29-32 and 36 have been rejected under 35 U.S.C. § 102(b) as allegedly being anticipated by Gilles. These rejections are respectfully traversed.

Applicants' amended independent claim 29 defines an electronic device for detecting a user's cardiac signal, including an enclosure, a heart sensor configured to detect the user's cardiac signal, and a processor coupled to the heart sensor. The heart sensor includes a first lead including a first pad that is embedded in a first portion of the enclosure, wherein an exterior surface of the enclosure includes an exterior surface of the first portion, wherein the first pad is positioned underneath the exterior surface of the first portion, and wherein the first pad is configured to detect a first electrical signal of the user's cardiac signal via the user's skin's contact with the exterior surface of the first portion of the enclosure. The heart sensor also includes a second lead including a second pad that is embedded in a second portion of the enclosure, wherein the second pad is configured to detect a second electrical signal of the user's cardiac signal via the user's skin's contact with at least one of the second pad and the second portion of the enclosure. The processor is configured to receive and process the detected cardiac signal, wherein the first lead further includes a first connector coupled to the first pad and configured to provide the first electrical signal detected by the first pad to the processor, and wherein the second lead further includes a second connector coupled to the second pad and configured to provide the second electrical signal detected by the second pad to the processor.

Application No. 14/136,658 (Attorney Docket No.: P7276USC1)

Reply dated September 2, 2016

Reply to Final Office Action of March 2, 2016

For example, "[h]eart sensor 112 can include one or more leads connected to the exterior of the electronic device such that the user may contact one or more of the leads to provide an electrical signal associated with the user's heart to heart sensor 112," and "[t]he cardiac signals detected by the heart sensor leads can be coupled to a processor incorporated in heart sensor 112, or instead provided to processor 102," where "[t]he processor may then analyze the received signals and generate, from the received signals, one or more characteristic quantities of the user's heartbeat or heart rate for authentication" (applicants' specification, paragraph [0033]). The "size and location of the leads can be selected to ensure that sufficient contact is made between the user (e.g., the user's hand or finger) and the leads for cardiac signals to be detected," where "each lead can include a pad or extended area placed on the outer or inner surface of an electronic device bezel or housing" or "an entire portion of the electronic device enclosure (e.g., a portion of a bezel or housing) can serve as a lead for the heart sensor," and the "pad or extended area can then be coupled to a wire or other connector for providing cardiac signals to a processor for processing" (applicants' specification, paragraph [0034]), such as leads 322 and 324 of FIG. 3. As a specific example, with respect to applicants' FIG. 4B, an enclosure of electronic device 450 may include a bezel 460, where, "[i]f the electrical conductivity and size of bezel 460, and the strength or characteristics of the cardiac signal provided by the user and detected by the heart sensor are adapted such that the signal can be transmitted along short distances in bezel 460, lead 472 of the heart sensor can be positioned against the back surface of bezel 460," or "lead 472 can be placed within the thickness of bezel 460 (e.g., in a pocket within the bezel wall), but underneath the outer surface of the bezel," where a "short thickness

Application No. 14/136,658 (Attorney Docket No.: P7276USC1)

Reply dated September 2, 2016

Reply to Final Office Action of March 2, 2016

of bezel 460 can allow electrical signals to propagate from the user to the outer surface of bezel 460, through bezel 460, and into lead 472, which may in turn transmit the signals to a processor using connector 474" (applicants' specification, paragraph [0047]).

Gilles is directed towards heart monitoring apparatus. Gilles' FIG. 5 shows apparatus including an auxiliary device 9 with a male coupling 11 on one face for coupling to a case 3, and a female coupling 12 on another face for coupling to auxiliary electrode 7. Auxiliary device 9 is connected to several other auxiliary electrodes 13, 14, and 15 which adhere to the patient's bust in pre-determined positions via wires, as shown in Gilles' FIG. 8.

Nowhere does Gilles show or suggest an electronic device with an enclosure and a heart sensor with a first pad embedded in a first portion of the enclosure and a second pad embedded in a second portion of the enclosure, where "an exterior surface of the enclosure comprises an exterior surface of the first portion, wherein the first pad is positioned underneath the exterior surface of the first portion, and wherein the first pad is configured to detect a first electrical signal of the user's cardiac signal via the user's skin's contact with the exterior surface of the first portion of the enclosure," as required by applicants' amended independent claim 29. That is, nowhere does Gilles show or suggest any electrode embedded in any portion of case 3 / auxiliary device 9, let alone show or suggest a first electrode embedded in a first portion of case 3 / auxiliary device 9 and a second electrode embedded in a second portion of case 3 / auxiliary device 9. Instead, each one of auxiliary electrodes 13, 14, and 15 of Gilles is distinct and independent from case 3 / auxiliary device 9 and is remotely coupled to case 3 / auxiliary device 9 via one or more wires of Gilles' FIG. 8.



Application No. 14/136,658 (Attorney Docket No.: P7276USC1)

Reply dated September 2, 2016

Reply to Final Office Action of March 2, 2016

On pages 2 and 3 of the Office Action, the Examiner attempts to equate the wire connecting electrode 13 to case 3 / auxiliary device 9 with the first lead of applicants' independent claim 29 and to equate the wire connecting electrode 14 to case 3 / auxiliary device 9 with the second lead of applicants' independent claim 29. However, applicants' amended independent claim 29 requires its first lead to include a first pad configured to "detect a first electrical signal of [a] user's cardiac signal via the user's skin's contact with [an] exterior surface of [a] first portion of [an] enclosure [in which the first pad is embedded]," and nowhere does Gilles show or suggest that the wire connecting electrode 13 to case 3 / auxiliary device 9 is configured to detect an electrical signal of a user's cardiac signal via the user's skin's contact with an exterior surface of case 3 / auxiliary device 9. Instead, Gilles' electrode 13 is only configured to detect an electrical signal of a user's cardiac signal via the user's contact with electrode 13, which is clearly distinct from and not embedded in case 3 / auxiliary device 9.

For at least these reasons, applicants respectfully submit that applicants' amended independent claim 29 and all claims dependent therefrom, including claims 30-36, 39, 44, 45, and 52-54, are allowable over Gilles. Therefore, applicants respectfully request that the rejections of claims 29-32 and 36 under 35 U.S.C. § 102(b) with respect to Gilles be withdrawn.

The Rejections Under 35 U.S.C. § 103(a)

Claims 33-35 and 39

Claims 33-35 and 39 have been rejected under 35 U.S.C. § 103(a) as allegedly being unpatentable over Gilles. Applicants respectfully submit that each one of claims 33-35 and 39, which depends from applicants' amended independent claim 29, is allowable

Application No. 14/136,658 (Attorney Docket No.: P7276USC1)  
Reply dated September 2, 2016  
Reply to Final Office Action of March 2, 2016

over Gilles for at least some of the same reasons as applicants' amended independent claim 29 is allowable over Gilles. Therefore, applicants respectfully request that the rejections of claims 33-35 and 39 under 35 U.S.C. § 103(a) with respect to Gilles be withdrawn be withdrawn.

Claims 40 and 42

Claims 40 and 42 have been rejected under 35 U.S.C. § 103(a) as allegedly being unpatentable over Gilles. These rejections are respectfully traversed.

Applicants' amended independent claim 40 defines an electronic device for detecting a user's cardiac signal, including an enclosure, a display screen exposed to the user through an opening in the enclosure, a heart sensor configured to detect the user's cardiac signal, and a processor coupled to the heart sensor. The heart sensor includes a first lead embedded in a first portion of the enclosure of the electronic device, wherein the first portion of the electronic device comprises an enclosure of the electronic device, wherein the first lead is configured to detect a first electrical signal of the user's cardiac signal via the user's contact with at least one of the first lead and the first portion of the enclosure of the electronic device. The heart sensor also includes a second lead embedded in the display screen of the electronic device, wherein the second lead is configured to detect a second electrical signal of the user's cardiac signal via the user's contact with at least one of the second lead and the display screen of the electronic device. The processor is configured to process the first and second electrical signals of the user's cardiac signal.

For example, as shown in applicants' FIG. 3, "electronic device 300 can include additional lead 326 embedded in or behind display 302," where "[l]ead 326 can be operative to detect a user's

Application No. 14/136,658 (Attorney Docket No.: P7276USC1)

Reply dated September 2, 2016

Reply to Final Office Action of March 2, 2016

heart activity as the user moves a finger across display 302," and, "[u]sing lead 326, the electronic device can detect an electrical signal from a different portion of the user's body (e.g., leads 322 and 324 detect signals through a first hand, and lead 326 detects signals through the second hand), which can provide the processor with additional information for determining characteristics of the user's cardiac activity" (applicants' specification, paragraph [0043]).

Gilles is directed towards heart monitoring apparatus. Gilles' FIG. 5 shows apparatus including an auxiliary device 9 with a male coupling 11 on one face for coupling to a case 3, and a female coupling 12 on another face for coupling to auxiliary electrode 7. Auxiliary device 9 is connected to several other auxiliary electrodes 13, 14, and 15 which adhere to the patient's bust in pre-determined positions via wires, as shown in Gilles' FIG. 8.

Nowhere does Gilles show or suggest an electronic device with a heart sensor that includes "a first lead embedded in a first portion of [an] enclosure of the electronic device," as well as "a second lead embedded in [a] display screen [exposed to the user through an opening in the enclosure] of the electronic device, wherein the second lead is configured to detect a second electrical signal of the user's cardiac signal via the user's contact with at least one of the second lead and the display screen of the electronic device," as required by applicants' amended independent claim 40. That is, nowhere does Gilles show or suggest any electrode embedded in any enclosure portion of case 3 / auxiliary device 9, let alone show or suggest a first electrode embedded in an enclosure of case 3 / auxiliary device 9 and a second electrode embedded in a display screen exposed to a user through an opening in such an enclosure of case 3 / auxiliary device 9. Instead, each one of auxiliary electrodes 13, 14, and 15 of Gilles is distinct and independent from

Application No. 14/136,658 (Attorney Docket No.: P7276USC1)

Reply dated September 2, 2016

Reply to Final Office Action of March 2, 2016

case 3 / auxiliary device 9 and is remotely coupled to case 3 / auxiliary device 9 via one or more wires of Gilles' FIG. 8.

Assuming, *arguendo*, that Gilles' auxiliary electrode 7 as coupled to case 3 / auxiliary device 9 may be equated with a first lead embedded in an enclosure of an electronic device, which applicants do not accept, nowhere does Gilles show or suggest any other electrode that may be embedded in case 3 / auxiliary device 9, let alone embedded in Gilles' display 24 as enclosed within case 3. In fact, each one of all other electrodes 13, 14, and 15 of Gilles' FIG. 8 is disclosed as being positioned at different positions along the user's body distanced via wires from the position at which case 3 / auxiliary device 9 / auxiliary electrode 7 / display 24 is positioned.

For at least these reasons, applicants respectfully submit that applicants' amended independent claim 40 and all claims dependent therefrom, including claims 42 and 46-51, are allowable over Gilles. Therefore, applicants respectfully request that the rejection of claims 40 and 42 under 35 U.S.C. § 103(a) with respect to Gilles be withdrawn.

Application No. 14/136,658 (Attorney Docket No.: P7276USC1)

Reply dated September 2, 2016

Reply to Final Office Action of March 2, 2016

Conclusion

In view of the foregoing, applicants respectfully submit that claims 29-36, 39, 40, 42, and 44-54 are allowable. This application is therefore in condition for allowance. Reconsideration and prompt allowance of this application are respectfully requested.

Respectfully submitted,

Date: September 2, 2016

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# **EXHIBIT 14**



UNITED STATES PATENT AND TRADEMARK OFFICE

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United States Patent and Trademark Office

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/826,130	03/20/2020	Fletcher R. Rothkopf	P22914USC4	4709
62579	7590	05/13/2020	EXAMINER	
APPLE INC./BROWNSTEIN			GEDEON, BRIAN T	
c/o Brownstein Hyatt Farber Schreck, LLP			ART UNIT	
410 Seventeenth Street			PAPER NUMBER	
Suite 2200			3792	
Denver, CO 80202			NOTIFICATION DATE	
			DELIVERY MODE	
			05/13/2020	
			ELECTRONIC	

**Please find below and/or attached an Office communication concerning this application or proceeding.**

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

patentdocket@bhfs.com

**Office Action Summary****Application No.**

16/826,130

**Applicant(s)**

Rothkopf et al.

**Examiner**

BRIAN T GEDEON

**Art Unit**

3792

**AIA (FITF) Status**

Yes

**-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --****Period for Reply**

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTHS FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

**Status**

- 1) ☒ Responsive to communication(s) filed on 24 March 2020.  
☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on \_\_\_\_.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on \_\_\_\_; the restriction requirement and election have been incorporated into this action.
- 4) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

**Disposition of Claims\***

- 5) ☒ Claim(s) 21-40 is/are pending in the application.  
 5a) Of the above claim(s) \_\_\_\_ is/are withdrawn from consideration.
- 6) ☐ Claim(s) \_\_\_\_ is/are allowed.
- 7) ☒ Claim(s) 21-40 is/are rejected.
- 8) ☐ Claim(s) \_\_\_\_ is/are objected to.
- 9) ☐ Claim(s) \_\_\_\_ are subject to restriction and/or election requirement

\* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see [http://www.uspto.gov/patents/init\\_events/pph/index.jsp](http://www.uspto.gov/patents/init_events/pph/index.jsp) or send an inquiry to [PPHfeedback@uspto.gov](mailto:PPHfeedback@uspto.gov).

**Application Papers**

- 10) ☐ The specification is objected to by the Examiner.
- 11) ☒ The drawing(s) filed on 20 March 2020 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.  
 Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).  
 Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

**Priority under 35 U.S.C. § 119**

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

**Certified copies:**

- a) ☐ All b) ☐ Some\*\* c) ☐ None of the:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

\*\* See the attached detailed Office action for a list of the certified copies not received.

**Attachment(s)**

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☒ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b)  
 Paper No(s)/Mail Date \_\_\_\_.
- 3) ☐ Interview Summary (PTO-413)  
 Paper No(s)/Mail Date \_\_\_\_.
- 4) ☐ Other: \_\_\_\_.

Application/Control Number: 16/826,130  
Art Unit: 3792

Page 2

## **DETAILED ACTION**

### ***Notice of Pre-AIA or AIA Status***

1. The present application, filed on or after March 16, 2013, is being examined under the first inventor to file provisions of the AIA.

### ***Priority***

2. This application is a continuation of US Application nos. 15/261,912, now US Patent no. 10,620,591; 15/261,914, now US Patent no. 10,613,485; and 15/261,917, now US Patent no. 10,627,783, filed 10 September 2016, which are continuations of US Application no. 14/842,617, now US Patent no. 10,599,101 filed 1 September 2015, which claim the benefit of priority from US Provisional Application no. 62/044,974 filed 2 September 2014.

### ***Information Disclosure Statement***

3. The information disclosure statement filed 20 March 2020 has been considered.

### ***Response to Amendment***

4. The preliminary amendment filed 24 March 2020 has been acknowledged. Claims 21-40 are pending, wherein claims 21-40 are new.

### ***Claim Rejections - 35 USC § 112***

5. The following is a quotation of the first paragraph of 35 U.S.C. 112(a):

(a) IN GENERAL.—The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise,

Application/Control Number: 16/826,130  
Art Unit: 3792

Page 3

and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same, and shall set forth the best mode contemplated by the inventor or joint inventor of carrying out the invention.

The following is a quotation of the first paragraph of pre-AIA 35 U.S.C. 112:

The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same, and shall set forth the best mode contemplated by the inventor of carrying out his invention.

6. Claim 32 is rejected under 35 U.S.C. 112(a) or 35 U.S.C. 112 (pre-AIA), first paragraph, as failing to comply with the written description requirement. The claim(s) contains subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor or a joint inventor, or for pre-AIA the inventor(s), at the time the application was filed, had possession of the claimed invention. The specification of the present invention fails to provide any description or critical teaching pertaining to cover having a circular shape with a diameter greater than the opening diameter of the second opening.

***Claim Rejections - 35 USC § 103***

7. In the event the determination of the status of the application as subject to AIA 35 U.S.C. 102 and 103 (or as subject to pre-AIA 35 U.S.C. 102 and 103) is incorrect, any correction of the statutory basis for the rejection will not be considered a new ground of rejection if the prior art relied upon, and the rationale supporting the rejection, would be the same under either status.

8. The following is a quotation of 35 U.S.C. 103 which forms the basis for all obviousness rejections set forth in this Office action:



Application/Control Number: 16/826,130  
Art Unit: 3792

Page 4

A patent for a claimed invention may not be obtained, notwithstanding that the claimed invention is not identically disclosed as set forth in section 102, if the differences between the claimed invention and the prior art are such that the claimed invention as a whole would have been obvious before the effective filing date of the claimed invention to a person having ordinary skill in the art to which the claimed invention pertains. Patentability shall not be negated by the manner in which the invention was made.

9. Claims 21-23, 26, and 27 is/are rejected under 35 U.S.C. 103 as being unpatentable over Hong et al. (US Publication no. 2014/0275852) in view of Schmid (US Patent no. 4,448,199).

In regard to claim 21, Hong et al. describe a wearable heart rate monitor in the form of an electronic wristwatch (figure 2a). Figure 2C shows that the watch is comprised of a housing formed from metal (para 164, some or all of the interior or skin-side housing consists of a metal material such as nickel-free stainless steel) wherein the housing has a rear opening (i.e., section of the housing bearing sensor protrusion in figure 2c), a touch sensitive display positioned partially within the housing (para 272, the display screen uses capacitive touch detection); an attachment band coupled to the housing and configured to couple the electronic watch to a user (para 108); a cover (i.e., protective transparent layer shown in figure 3A) covering an optical sensor and creating a seal along the rear opening of the housing (para 148, 155, 165), the protective transparent layer may be formed from a dielectric material (e.g., plastic or glass) (para 144); and an optical biosensor positioned within the rear opening of the housing and configured to transmit an optical signal through the transparent cover via LED sources and receive reflected light via photodetector in order to measure a heart rate of a user (figures 2C and 3A-3C, para 136-147, 159).

Hong et al. is considered to substantially suggest the invention as claimed, however does not include electrodes for sensing an electrocardiogram of a user.

Application/Control Number: 16/826,130  
Art Unit: 3792

Page 5

Schmid describes a wrist worn device similar to a wrist watch that includes a first electrode and second electrode (electrodes 21) located on the rear side of housing 2 configured to contact a user's skin when worn on the wrist provide a measure of the user's electrocardiogram (col 5 lines 24-37). Thus Schmid demonstrates that wrist worn electrocardiogram measurement devices were known in the art. As electrocardiograms are known biometric signals for accessing a patient's health, modification of the health monitor of Hong et al. to include electrodes for measuring an electrocardiogram is considered to have been obvious to one of ordinary skill in the art at the time of the invention since the modification is considered to comprise combining prior art elements according to known methods to yield predictable results. Further, Hong et al. suggests that electrocardiographic measurement components may be incorporated with the device (para 408).

In regard to claim 22, figures 2C and 3A-3C of Hong et al. show that the optical sensor comprised of LED sources and photodetector protrudes outward from the rear housing, wherein the optical sensor is covered by a transparent layer (i.e., a window) (para 144).

In regard to claim 23, the cover (i.e., protective transparent layer shown in figure 3A) in Hong et al. covers the optical sensor and creates a seal along the rear opening of the housing (para 148, 155, 165), the protective transparent layer may be formed from a dielectric material (e.g., plastic or glass) (para 144).

In regard to claim 26, the monitoring device of Hong et al. includes a near-field communication system (i.e., Bluetooth) configured to transmit signals through the housing (para 133 and 177).

Application/Control Number: 16/826,130  
Art Unit: 3792

Page 6

In regard to claim 27, Hong et al. as modified by the disclosure of Schmid would include the electrodes for electrocardiogram measurement on the rear side of the housing as depicted in figure 1 of Schmid.

10. Claims 24 and 25 is/are rejected under 35 U.S.C. 103 as being unpatentable over Hong et al. (US Publication no. 2014/0275852) in view of Schmid (US Patent no. 4,448,199), further in view of Mistry et al. (US Publication no. 2014/0139486).

In regard to claim 24, Hong et al. in view of Schmid substantially describes the invention as claimed. Hong et al. also teaches that the wearable electronic device includes an internal rechargeable battery wherein the device may engage a charger such as a docking station using magnetic properties between magnets located in the charger and wearable device to facilitate battery recharge (para 305 and 306). The transmission of recharge energy from the charger may be wireless (para 306). However, Hong et al. is not clear if there is a recharging receive coil located within the device to receive charging energy. Mistry et al., similar to Hong et al., describes a wearable sensing device with similar charging features (para 125-129). To facilitate charging of the device, the wearable device or band may include an antenna or coil located therein to receive recharging energy from the charger and is positioned to properly align with the charger coil to optimize power transfer (para 128). The antenna of Mistry et al. is considered similar to the coil as claimed. Both Hong et al. and Mistry et al. are considered to teach the necessary elements, or suitable equivalents, for functionally providing wireless energy transfer for recharging the battery. While neither reference explicitly teaches the arrangement of the elements in the manner as claimed,

Application/Control Number: 16/826,130  
Art Unit: 3792

Page 7

modification of the charging elements described by the prior art in the manner as claimed is considered to have been obvious to one of ordinary skill in the art at the time of the invention since the modification is considered to comprise the rearrangement of essential working elements according to known functional performance characteristics in order optimize energy transfer between devices and facilitate compact circuit design.

In regard to claim 25, both Hong et al. and Mistry et al. discuss the use of magnets located within the housing and charging device in order to maintain alignment between the two elements (Hong et al. para 164, 305, and 306; Mistry et al. para 126-128).

11. Claims 28-33, 35-37, and 40 is/are rejected under 35 U.S.C. 103 as being unpatentable over Hong et al. (US Publication no. 2014/0275852) in view of Mistry et al. (US Publication no. 2014/0139486).

In regard to claims 28 and 35, Hong et al. substantially describes the invention as claimed. Hong et al. also teaches that the wearable electronic device includes an internal rechargeable battery wherein the device may engage a charger such as a docking station using magnetic properties between magnets located in the charger and wearable device to facilitate battery recharge (para 305 and 306). The transmission of recharge energy from the charger may be wireless (para 306). However, Hong et al. is not clear if there is a recharging receive coil located within the device to receive charging energy. Mistry et al., similar to Hong et al., describes a wearable sensing device with similar charging features (para 125-129). To facilitate charging of the device, the wearable device or band may include an antenna or coil located therein to

Application/Control Number: 16/826,130  
Art Unit: 3792

Page 8

receive recharging energy from the charger and is positioned to properly align with the charger coil to optimize power transfer (para 128). The antenna of Mistry et al. is considered similar to the coil as claimed. Both Hong et al. and Mistry et al. are considered to teach the necessary elements, or suitable equivalents, for functionally providing wireless energy transfer for recharging the battery. While neither reference explicitly teaches the arrangement of the elements in the manner as claimed, modification of the charging elements described by the prior art in the manner as claimed is considered to have been obvious to one of ordinary skill in the art at the time of the invention since the modification is considered to comprise the rearrangement of essential working elements according to known functional performance characteristics in order optimize energy transfer between devices and facilitate compact circuit design.

In regard to claims 29 and 36, in figures 3A and 3B, Hong et al. shows that the optical sensor includes a plurality of LED sources and a photodetector covered by protecting transparent layer. The protective layer serves as a window to provide operational access to the elements of the optical sensor. The prior art does not teach several separate windows such as the array of window aligned with each respective optical components of the sensor module. However, the specification of the present invention lacks a critical teaching for this particular structure, and this therefore interpreted to be a modification modified by choice of the designer. In view of this, the modification with respect to the cover shape and size is considered obvious to one of ordinary skill in the art based on choice in design.

In regard to claim 30, figures 2C and 3A-3C of Hong et al. show that the optical sensor comprised of LED sources and photodetector protruding from the sensor. The



Application/Control Number: 16/826,130  
Art Unit: 3792

Page 9

LEDs and photodetector form an optical sensor that may function as a PPG (para 136-138 and 162).

In regard to claim 31, in figures 2B and 3A-3C of Hong et al., the cover protrudes outward from the rear surface of the housing and defining a convex exterior profile. The convex exterior profile of Hong et al. is structured as claimed and capable of being used to mate with a complementary surface.

In regard to claim 32, the over in Hong et al. forms a water tight seal with the housing. The protective transparent cover is circular in design, however does not have the specific features with respect to the size of the diameter related to opening diameter. The specification of the present invention lacks a critical teaching for this particular feature suggesting that this feature is based on choice of the designer. In view of this, the modification with respect to the cover shape and size is considered obvious to one of ordinary skill in the art based on choice in design.

In regard to claims 33 and 40, both Hong et al. and Mistry et al. discuss the use of magnets located within the housing and charging device in order to maintain alignment between the two elements (Hong et al. para 164, 305, and 306; Mistry et al. para 126-128).

In regard to claim 37, Hong et al. teaches that the biosensor may include an optical sensor that comprises LED sources and photodetector to serve as a PPG and measure heart rate (para 136-138 and 162). The display of Hong et al. is configured to and capable of displaying the data acquired and processed by the device.

Application/Control Number: 16/826,130  
Art Unit: 3792

Page 10

12. Claims 34, 38, and 39 is/are rejected under 35 U.S.C. 103 as being unpatentable over Hong et al. (US Publication no. 2014/0275852) in view of Mistry et al. (US Publication no. 2014/0139486), further in view of Schmid (US Patent no. 4,448,199).

In regard to claims 34, 38, and 39, Hong et al. in view of Mistry et al. are considered to suggest the invention as claimed except for the addition of a first electrode and second electrode on the housing to sense electrocardiogram signals. Schmid describes a wrist worn device similar to a wrist watch that includes a first electrode and second electrode (electrodes 21) located on the rear side of housing 2 configured to contact a user's skin when worn on the wrist provide a measure of the user's electrocardiogram (col 5 lines 24-37). Thus Schmid demonstrates that wrist worn electrocardiogram measurement devices were known in the art. As electrocardiograms are known biometric signals for accessing a patient's health, modification of the health monitor of Hong et al. to include electrodes for measuring an electrocardiogram is considered to have been obvious to one of ordinary skill in the art at the time of the invention since the modification is considered to comprise combining prior art elements according to known methods to yield predictable results. Further, Hong et al. suggests that electrocardiographic measurement components may be incorporated with the device (para 408).

***Statement on Communication via Internet***

13. Communications via Internet e-mail are at the discretion of the applicant. Without a written authorization by applicant in place, the USPTO will not respond via Internet e-mail to any Internet correspondence which contains information

Application/Control Number: 16/826,130  
Art Unit: 3792

Page 11

subject to the confidentiality requirement as set forth in 35 U.S.C. 122. Where a written authorization is given by the applicant, communications via Internet e-mail, other than those under 35 U.S.C. 132 or which otherwise require a signature, may be used. USPTO employees are NOT permitted to initiate communications with applicants via Internet e-mail unless there is a written authorization of record in the patent application by the applicant. The following is a sample authorization form which may be used by applicant:

"Recognizing that Internet communications are not secure, I hereby authorize the USPTO to communicate with me concerning any subject matter of this application by electronic mail. I understand that a copy of these communications will be made of record in the application file."

Please refer to MPEP 502.03 for guidance on Communications via Internet.

### ***Conclusion***

14. Any inquiry concerning this communication or earlier communications from the examiner should be directed to BRIAN T GEDEON whose telephone number is (571)272-3447. The examiner can normally be reached on M-F 8:00 am to 5:30 PM ET.

Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an interview, applicant is encouraged to use the USPTO Automated Interview Request (AIR) at <http://www.uspto.gov/interviewpractice>.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Carl H Layno can be reached on 571-272-4949. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Application/Control Number: 16/826,130  
Art Unit: 3792

Page 12

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/BRIAN T GEDEON/  
Primary Examiner, Art Unit 3792  
8 May 2020

# **EXHIBIT 15**

Filed on behalf of **Masimo Corporation**

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UNITED STATES PATENT AND TRADEMARK OFFICE

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**BEFORE THE PATENT TRIAL AND APPEAL BOARD**

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MASIMO CORPORATION,  
Petitioner

v.

APPLE INC.,  
Patent Owner

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Case No. IPR2023-00634  
Patent No. 10,627,783

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**PETITION FOR *INTER PARTES* REVIEW OF  
U.S. PATENT NO. 10,627,783**